Final Report

Agreement # 08-PML-G003

Management of Pesticide Runoff in the San Joaquin-Sacramento Delta And San Joaquin County Waterways

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Submitted by:
San Joaquin County Resource Conservation District
3422 W. Hammer Lane, Suite A
Stockton, CA 95219
(o) 209-472-7127 ext. 125
(c) 209-327-2823
(f) 209-472-7890
info@sjcrcd.org
rvranglr@yahoo.com
www.sjcrcd.org

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Final Report

Executive Summary

In order to complete the tasks outlined in the agreement, the San Joaquin County Resource Conservation District (SJCRCD) subcontracted with the Lodi Winegrape Commission, and Terry Prichard, Water Management Specialist, Emeritus, Dept., LAWR, UC Davis, in addition to two SJCRCD subcontractors working on these issues as a part of SJCRCD efforts to help local growers comply with the Central Valley Water Quality Control Board's Irrigated Lands Regulatory Program (ILRP).

The purpose of the project was to demonstrate the effectiveness of Integrated Pest Management (IPM) in agriculture involving pesticides of human health concern found in water. The project seeks to address non-point source runoff from specific agricultural sources into the waterways of San Joaquin County and the legal Delta. The sources to be addressed by the project include pesticides used on alfalfa, walnuts, tomatoes, and winegrapes.

The primary goal of the project is a 10% reduction in toxicity hits due to targeted pesticides in regular water quality monitoring for the ILRP in San Joaquin County and the Delta. The intermediate goal was to reduce toxicity occurrences in testing at targeted monitoring sites by 3% at the end of the 2009 growing season, by 6% t the end of the 2010 growing season, and by 10% as the 2010/2011 storm season closes.

The objective to achieve the goal was to create and implement grower self-assessment workbook for alfalfa, walnuts, tomatoes, and winegrapes. Though adaptive management of the project led to changes in the objectives and tasks, most of the goals of the project were achieved. For those goals that might not have been fully achieved through the term of this project, the tools are in place to reach the goals in the future.

It is expected that the lessons learned through this project can be applied statewide. The first step toward seeing that this information gets shared is the publishing of the workbooks written as a result of this project. They are posted on the University of California Agricultural and Natural Resources (UCANR) Publications website: http://anrcatalog.ucdavis.edu

Highlights of project accomplishments include:

- When comparing the baseline water column exceedance count for chlorpyrifos, the total target area experienced a 36% reduction in 2010 compared to the baseline year of 2008.
- A 54% reduction in average water column chlorpyrifos exceedance concentration was also found during the same period.
- There were no exceedances of water quality standards occurred in 2010 for diazinon nor malathion in the target area, down from one each in 2008.
- Exceedances due to chlorpyrifos or pyrethroids were reduced by 67% from 2008 to 2010 in the target area.

- The number of applications and amount (pounds) of active ingredient for both chlorpyrifos, diazinon, and pyrethroids applied to the total target area declined drastically from 2008 to 2010.

Introduction

Project Description and Design

The purpose of the project was to demonstrate the effectiveness of Integrated Pest Management (IPM) in agriculture involving pesticides of human health concern found in water. These pesticides are also thought to contribute to other environmental concerns in the San Joaquin-Sacramento Delta such as in connection to Pelagic Organism Decline. The specific materials to be addressed by the project include pesticides used on alfalfa, walnuts, tomatoes, and winegrapes.

"IPM, is a long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. It coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment. IPM serves as an umbrella to provide an effective, all encompassing, low-risk approach to protect resources and people from pests." (USDA, 2004) Evaluating pesticide options for risks, choosing least-risk products, and implanting management practices specific to crops and conditions and pathways to exposure are key components of IPM. For example, if risks to aquatic ecosystems are high due primarily to runoff, a vegetative buffer may be appropriate; however, if drift is the primary exposure pathway, a change in application method may be more effective.

The San Joaquin County Resource Conservation District (SJCRCD) is the lead agency for the San Joaquin County and Delta Water Quality Coalition (Coalition). The Coalition includes parts of Alameda, Contra Costa, Calaveras, San Joaquin, and Stanislaus counties and comprises approximately 2,156,031 acres, of which 28% (approximately 609,134 acres) is considered irrigated agriculture (Department of Water Resources (DWR, 2001). The northern border of the Coalition area corresponds to the county line between San Joaquin and Sacramento counties. A variety of crops is grown within the Coalition boundaries and different crops are often found in regions with specific microclimate, soil type, and local farming history.

The Coalition is monitoring agricultural runoff as prescribed by the ILRP across San Joaquin County and the legal Delta. The long-term goal of the Coalition is to assist in the elimination of toxicity hits caused by chemicals monitored as a part of the ILRP. In the course of monitoring, several pesticides were detected in waterways throughout the Coalition area, including: chlorpyrifos, diazinon and carbofuran. There were also sediment toxicity exceedances due to pyrethroids. This project focused on preventing these materials and others from entering waterways by implementing practices known to reduce or prevent pesticide runoff. This project also proposed to evaluate efficacy and costs of experimental practices under study by UCCE.

The primary goal of the project is a 10% reduction in toxicity hits due to targeted pesticides in regular water quality monitoring for the Irrigated Lands Regulatory Program (ILRP) in San Joaquin County and the Delta. The intermediate goal was to reduce toxicity occurrences in testing at targeted monitoring sites by 3% at the end of the 2009 growing season, by 6% by the end of the 2010 growing season, and by 10% as the 2010/2011 storm season closes.

The overall objective to achieve the goal was to create and implement grower self-assessment workbook for alfalfa, walnuts, tomatoes, and winegrapes. Though adaptive management of the project led to changes in the objectives and tasks (changes will be detailed later in the report), most of the goals of the project were achieved. For those goals that might not have been fully achieved through the term of this project, the tools are in place to reach the goals in the future.

There were four objectives identified to meet the specific outcomes of this project. The first objective was to continue the Coalition's communication with members and others regarding the importance of using management practices. The Coalition has been reinforcing the management practice message since the ILRP began. Those activities are required for participation in the ILRP and were used as match for the purposes of this grant.

The second objective was to develop a single self-assessment workbook designed to allow individual producers assess the risk of chemical residues in their agricultural runoff by identifying where they might reduce either the occurrence of runoff or reduce pesticides that enter runoff. The workbook was expected to include chapters on management practices for each of four different commonly grown crops in the Coalition area that utilize pesticides of concern. The workbook will also describe best management practices and runoff management management practices and how they can be implemented.

There was a delay in creating the grower self-assessment workbook. The major reason for the delay in the workbook development was a determination by the peer review committee that major changes were needed to the winegrape section. The winegrape section was the first part of the workbook under development.

The winegrape section was chosen for completion first because there was already a prototype workbook available from the Lodi Winegrape Commission. That workbook, *The Lodi Winegrowers Workbook*, was later was developed into *The Code of Sustainable Winegrowing Practices Self-Assessment Workbook for the California Wine Community*. That self-assessment manual went beyond winegrape growing to include the entire winemaking process. The developer and co-author of *The Lodi Winegrowers Workbook*, Cliff Ohmart, Ph.D. was an original project team member.

Project team members agreed it was more prudent to develop the winegrape section of the workbook based on an established publication rather than start from scratch. Initial discussions among project team members centered on which portions of the winegrape growers workbook should be included in the project workbook. Dr. Ohmart's task was to condense portions of the established workbook for this project beginning in early December 2008.

At this same time, the state of California experienced budget difficulties which resulted in most state grant funded projects being suspended just prior to the 2008 Christmas holidays. Due to confusion and uncertainty about which projects would continue and which should be suspended, the SJCRCD Board of Directors ordered a suspension of all grant funded projects. This self-imposed suspension lasted for approximately two months until the SJCRCD received assurances from DPR that this project was not subject to bond funding and could proceed.

The task of condensing the existing winegrowers' workbook began in earnest with peer reviews of a table of contents for the project workbook; to be sure all necessary subjects were covered. At this time, it was the intention of the workbook team to keep the self-assessment format of the existing winegrowers' workbook. The first draft of the winegrowers' portion of the workbook was submitted to the workbook team in March 2009.

At the workbook team meeting in April 2009, it was determined that a single workbook for all four crops would be very large, had the potential to be confusing, and as such was unlikely to be well received by the grower community. The primary reasons for this conclusion were the significant differences between pests, pest control materials, irrigation systems, and potential management mitigation practices. At this meeting, it was suggested that four smaller workbooks, one for each crop (winegrapes, tomatoes, alfalfa, and walnuts) be developed. It was agreed the individual workbook approach was the best for successful grower acceptance of the materials.

Meetings of the workbook team in May and June 2009 focused on finalizing the winegrape workbook draft. Discussion centered on technical aspects of the self-assessment, especially how to bring together the need for grower assessment of pest problems versus the need for a discussion of management practices. Monthly workbook meetings held from July through September centered on the incorporation of the assessment and scoring system employed by the *Lodi Winegrowers Workbook* for the project workbook.

Two things happened in October 2009. First, Dr. Ohmart took a position with a different organization in a different part of the state and left the Lodi Winegrape Commission and the project team. Second, after nearly finalizing the project workbook for winegrapes, it was determined by the workbook team that the current format was unsuitable for the information that should be presented. The scoring option of the self-assessment workbook was eliminated in favor of a different format with more information on management practices.

The length and complexity of the project workbook continued to be an issue for the project team and they continued work to edit and condense the draft. Work was now underway on the other workbooks for this project focusing on tomatoes, alfalfa, and walnuts and was based on the new format and incorporating comments of peer reviewers through the December workbook team meeting. The new format was fully incorporated in all workbooks, and focused on a flow chart system for the growers to follow rather than a self-assessment scoring system. Workbook team members were prepared to submit the workbooks for editing and field testing.

Though the delay in workbook development was unfortunate, the consequences of the delay are a shorter, more user-friendly workbook that is more likely to be used by the growers than the original self-assessment format used in the Winegrowers workbook. While the winegrowers' workbook is successful in its own right, filling it out is a process that requires a time commitment that many growers simply can't make. Some grape growers might be familiar with the demands of such a workbook due to the Lodi workbook and "Lodi Rules for Sustainable Winegrape Growing" program, but growers of other crops are not and it was anticipated that they would be intimidated by the size and complexity of a publication similar to the original winegrowers workbook.

Under the proposed workbook design (the design of the Lodi Winegrowers Workbook), a moderator was necessary to introduce the workbook format and scoring of the self-assessments. With the elimination of the practice scoring focus, the workbook(s) can be used by individual growers using only written instructions if necessary. By crafting workbooks that can be used without the need or preferred format of a grower meeting and moderator instruction, it is more likely these workbooks will be used and therefore makes the project more effective than originally designed.

The current format using flow charts and management practices is much more user friendly, and was well-received by both peer reviewers and growers during field testing of the prototypes. The end result is that it is more likely that the workbooks in their current format will be used than the workbooks using the previous format. More use by growers should translate into more management practices implemented and less constituent runoff from crop areas.

The third objective was to conduct workshops and seminars in targeted areas to inform local producers of effective management practices, and to demonstrate the effectiveness of the workbook. While there are lists of generic management practices for different crops, new research was helping determine which practices are most effective under site-specific conditions. SJCRCD planned to use Coalition seminars and small group meetings as well as those of other agencies and organizations to disseminate the latest and best information.

Due to the time needed to craft effective individual workbooks, there was a delay in the Task 3 implementation of workbook workshops. The impact on project effectiveness is the loss of workshops and workbook use during the 2009 growing season, and, for some project crops, the early portion of the 2010 growing season. Time available for workbook pretesting by growers with feedback to the authors was reduced accordingly. However, the number of outreach meetings conducted with growers during the 2008-2010 time period, using the same materials, modified this effect.

The finished products are more user-friendly and the workshops are not as important for the current format compared to the self-assessment scoring format. Additionally, all growers in the target area who did not attend the grower workshops in the target area were mailed two copies (one for their pest control adviser).

Implementation of management practices and runoff prevention/mitigation BMPs was ongoing through ILRP activities in 2008. The project team had to develop criteria for designating certain BMP runoff management practices for evaluation as experimental. In addition, project team members had to consult with UC IPM Advisors about which IPM practices could be considered experimental in the context of this project. All experimental practices were implemented and evaluated in 2009 with the exception of a winter tillage/cover crop evaluation (in winter of 2010) which was repeated to gain efficacy data.

This task also included determining the cost of the experimental practices. The objective was to give growers clear, reliable, ballpark cost estimates of BMP installation. This should make it easier for growers to make management decisions about practice selection and implementation, based on costs for their unique operation and business characteristics. Agriculture is a business, and providing cost information will help growers make decisions that benefit both water quality and their business operation.

The fourth objective was to oversee implementation of management practices that integrate the latest and most effective IPM practices, including experimental practices, and report the rationale and costs of those experimental practices. The Coalition is working constantly with its members under the ILRP to reduce agricultural non-point source runoff, and has been successful in securing producer interest in trying and demonstrating new management practices.

In order to evaluate the effectiveness of the project, project proponents proposed to analyze baseline water quality data. Regular water quality monitoring according to the provisions of the ILRP would be conducted during the course of the project term utilizing matching funds. The purpose of this monitoring would be to gather water quality data so baseline data could be compared with data collected as best management practices were implemented in target watersheds where chemicals of concern cause toxicity.

There were five changes in the deliverables/scope of work for this project. The first change was to move from creating one workbook covering all four target crops to creating four individual workbooks, one for each of the target crops identified in the original proposal. By changing to single crop workbooks, the workload was substantially increased.

Initially, the work would have been limited to merely adapting the Lodi Winegrowers' Workbook for other crops. The change occurred not only in design of the workbook(s) but also from a self-assessment workbook to workbooks that focused on evaluating the risk of offsite pesticide residues and management practices to mitigate the risk.

The second change in scope was the addition of another subwatershed to the target area. The original target area for this project included the Duck Creek, Lone Tree Creek, and Temple Creek subwatersheds. The Littlejohns Creek subwatershed was added to the target area to provide a contiguous target area. Littlejohns Creek is located between the Duck and Temple Creek subwatersheds. In addition to providing a contiguous target area, many growers farm in more than one of the subwatersheds in the area. The added area represented about 46% more irrigated acres to the original three subwatersheds. The four target crops of this project represent 40,233 irrigated acres in the target area, or about 46% of the total irrigated crop acreage.

The third change to the scope of the project was to redefine the constituents of concern. Originally these included constituents which were found in exceedance in the target area by the

Coalition's monitoring program. They included chlorpyrifos, carbofuran, and diazinon. By the time the project was in operation, carbofuran was no longer listed as a material for use by the San Joaquin County Agricultural Commissioner and therefore was no longer a target pesticide for the project. Another pesticide, malathion, was also found in exceedance of water quality standards in 2008 in the target area was added to the constituents of concern. Since sediment toxicities were thought to be caused by chlorpyrifos or pyrethroids, pyrethroids were added to the constituents of concern.

The fourth change to the scope of the project was to define experimental practices to include management practices specific to crops and conditions that serve as pesticide residue pathways to surface waters that are not widely in use. These include pesticide runoff best management practices (including IPM). The workbook team members designated certain runoff management practices as experimental. Team members also consulted with UC IPM Advisors to determine which management practices can be considered experimental in the context of this project.

The fifth change was a change from publishing a limited number of the self-assessment workbooks for coalition use at grower meetings to a peer reviewed University of California Agricultural and Natural Resources on-line, free downloadable publication.

The Californian Department of Pesticide Regulation (DPR) awarded SJCRCD a total of 175,000.00 to complete the project.

Project Team

The management team for the project included John Brodie, Mike Wackman, Terry Prichard, and Clifford Ohmart. John Brodie is the principal investigator for this project, and primarily responsible for project administration and reporting, and to assist as needed in creating the grower self-assessment and producer outreach and education. Mike Wackman served as SJCRCD Grant Manager for this project. Mr. Wackman had primary responsibility for creating the grower self-assessment workbook and producer outreach and education. Terry Prichard, Ph.D, is a Water Management Specialist, Emeritus, Dept., LAWR, UC Davis and Management Practice Specialist for the Coalition. Dr. Prichard was primarily responsible for creating the grower self-assessment workbook, grower outreach and education, and analysis of water quality monitoring data collected. Clifford Ohmart, Ph.D, was the IPM and research director for the Lodi Winegrape Commission and has developed self-assessment manuals in California and co-authored the Lodi Winegrowers Workbook, which would later be adapted and released as the California Wine Industry Workbook. Dr. Ohmart assisted with creating the grower self-assessment workbook before he left the Lodi Winegrape Commission in September 2009.

Project Term

The term of the project was September 1, 2008 to May 13, 2011

Project Setting

The Coalition is one of several formed up and down California's Central Valley to comply with the requirements of the Water Board's ILRP. All information on practices is shared with the

Regional Water Quality Control Board and other coalitions. Word of successful management practices noted by this Coalition is reported to the Regional Board, other coalitions, and other interested parties. That information will quickly spread elsewhere for further application and testing under different soil and crop conditions.

The key to the ILRP is the reduction, prevention, and eventual elimination of the movement of contaminants to surface waters. This project proposed implementation of IPM and pesticide management practices to progress toward that goal.

This project focused on four crops within a target implementation area. The target area is four contiguous subwatersheds comprising nearly 69,000 irrigated acres located on the eastern side of San Joaquin County. The crops are alfalfa, tomatoes, walnuts and winegrapes. The acreage of each crop was determined based on a GIS land use layer.

Each of the four crops are grown in the subwatersheds that make up the target area, with the exception of tomatoes in the Lone Tree Creek subwatershed. Water quality monitoring conducted for the Central Valley Regional Water Quality Control Board's ILRP indicates that discharge levels of pesticides targeted by this project exceed water quality standards. The combination of crops grown in the area and the record of exceedances make this area an ideal setting to implement this project.

There are 40,223 total irrigated acres of focus crops in an implementation area consisting of more than 68,500 acres of irrigated agriculture. This includes 7,252 irrigated acres of winegrapes, 12,106 irrigated acres of walnuts, 13,800 irrigated acres of tomatoes, and 7,075 irrigated acres of alfalfa.

At the time the project started, work was underway in the target area to identify management practices and to identify areas where those practices are under-utilized. The Coalition, SJCRCD and Stockton office of the United States Department of Agriculture Natural Resources Conservation Service (NRCS) were collaborating to implement best management practices for irrigated agriculture. The Coalition was working to implement management plans crafted in consultation with the Central Valley Regional Water Board to meet requirements of the ILRP. These management plans included grower education and outreach about management practices to reduce non-point source agricultural runoff. Those management plans dovetailed with this project in the effort to reduce pesticides of human health concern that enter waterways.

The Coalition has been monitoring water quality according to guidelines of the ILRP since 2005. Due to that surface water monitoring, the SJCRCD already had excellent baseline information for measuring the effectiveness of this and a similar project funded through the State Water Board. Combined with mapping and data the Coalition and SJCRCD compiled regarding areas where there were persistent toxicity issues related to specific chemicals, project proponents were reinforcing the message about currently available best management practices and introducing further mitigative management practices to these areas in an effort to reduce the contaminants that enter runoff.

Work Plan and Deliverables

There were four tasks proposed for this project. The tasks and deliverables proposed were as follows.

Task 1 Grant Administration

Subtask 1.1 Complete all subcontractor agreements. Deliverable: copy of subcontract. Projected date for completion: 09/01/08. **Subtask 1.2** Submit quarterly progress reports and invoices. Deliverables: submission of reports and invoices in specified format by specified dates. Projected date for completion: All quarterly reports and invoices (except for final report and final invoice) 02/01/2011. **Subtask 1.3** Submit draft final report. Deliverable: submission of draft final report in specified format. Projected date for completion: 04/01/2011. **Subtask 1.4** Submit final report. Deliverable: copy of final report in specified format. Projected date for completion: 05/13/2011

Subtasks 1.1 and 1.2 are complete. The submission of this report and subsequent final invoice will complete subtask 1.3 and all items under this task. No analysis pending for this task.

Task 2 Create Grower Self-Assessment Workbook

Subtask 2.1 Convene workbook team. Deliverables: agendas, notes, and attendance sheets from monthly meetings of the workbook team. Projected date for completion: 04/01/09. **Subtask 2.2** Peer review of workbook. Deliverable: summary of comments submitted by workbook reviewers. Projected date for completion: 06/01/2009. **Subtask 2.3** Field test workbook. Deliverable: summary of evaluation sheets submitted by growers. Projected date for completion: 11/01/2009. **Subtask 2.4** Print/Publish self-assessment workbooks. Deliverable: one copy of the workbook. Projected date for completion: 01/01/2010.

- *Subtask 2.1 Convene Workbook Team*

Workbook team and major contribution to writing workbooks (Table 2-1) and workbook team meeting dates and locations (Table 2-2).

Table 2-1 Workbook Contributions

Team Member	Winegrape	Walnut	Tomato	Alfalfa	Administration
Paul Verdegaal, UC Viticulture Farm Advisor, San Joaquin County	X				
Joe Grant, UC Pomology Farm Advisor, San Joaquin County		X			
Brenna Aegerter, UC Vegetable Crops Farm Advisor, San Joaquin County			X		
Mick Canevari, UC Field Crops Farm Advisor, San Joaquin County				X	
Cliff Ohmart, Previous Sustainable Winegrowing Director, Lodi Winegrape Commission	X				
Terry Prichard, UC Water Management Specialist Emeritus, UC Davis, LAWR	X	X	X	X	
Larry Schwankl, UC Irrigation Specialist, UC Davis, LAWR	X	X	X	X	
John Brodie , Principal Investigator, San Joaquin County Resource Conservation District					X
Mike Wackman, Grant Manager, San Joaquin County Resource Conservation District					X

Table 2-2 Workbook Team Meeting Dates and Locations

Date	Location
December19, 2008	Lodi
April 17, 2009	Stockton
May 28, 2009	Stockton
June 26, 2009	Stockton
August 26, 2009	Stockton
September 15, 2009	Stockton
September 15, 2009	Stockton
October 20, 2009	Stockton
November 18, 2009	Stockton
December 22, 2009	Stockton
January 19, 2010	Stockton
February 11, 2010	Stockton
February 25, 2010	Stockton
March 5, 2010	Stockton
April 7, 2010	Stockton
May 7, 2010	Stockton
June 17, 2010	Stockton
July 28, 2010	Stockton
August 26, 2010	Stockton
September 13, 2010	Stockton
December 16, 2010	Stockton
January 27, 2011	Stockton
February 25, 2011	Stockton

Agendas, notes and attendance from workbook team meetings (not previously reported in semi-annual reports).

<u>December 16, 2010</u>
Attending: Joe Grant, Brenna Aegerter, Paul Verdegaal, and Terry Prichard and Mick Canevari. Topics: Discussion of PMA project presentation at DPR. Discuss the Tomato Workbook Meeting with 8 out of 12 growers attending. Reviews received and to be incorporated into current versions. Budget redo required to move forward with UCANR publishing option. A meeting was held 12/7/10 with Joyce Strand(UCIPM), Pete Goodell (UCIPM), Terry Prichard, Jay Gan (UCR) and Rachael Long(Rachael and Jay are authors of UC Pub 8161). The IPM site water tox information is uploaded from a USDA database with no alteration. The method used by USDA in determining risk is apparently different than that used by Long and Gan. The USDA method incorporates a soil loss potential factor that may cause the errors. More work on this to come.

Assignments: Terry will address/ incorporate any outstanding review comments. The team members whose primary charge was to prepare a specific workbook will meet to make final changes before submitting to UCANR. Terry will continue the dialogue between the UCR group and UCIPM group to work out the differences in pyrethroid solution runoff risks.

January 27, 2011
Attending: Joe Grant, Brenna Aegerter, Paul Verdegaal, and Terry Prichard and Mick Canevari.
Topics: discussed the issue of a budget redo to facilitate UCANR publication while still retaining funds to provide hard copies to use at future meetings. Continued editing to bring all four crop chapters into a similar format. Discussion concerning the water tox IPM web information. Seems like IPM will pull down the water tox ratings for fish and replace with the runoff and adsorption risk at some future date pending a meeting and final decision. Decision made to use Pub 8161 insecticide data and add new compounds.

February 25, 2011
Attending: Joe Grant, Brenna Aegerter, Paul Vergegaal, and Terry Prichard.
Topics: Manuscript submission with unified format.

- *Subtask 2.2 Peer Reviews of Workbooks*

Workbook reviewers and affiliation by workbook.

Winegrape	Walt Bentley, UC Integrated Pest Management Entomologist Rhonda Smith, UC Viticultural Farm Advisor Pat Matteson, Staff Environmental Scientist, DPR
Walnut	Carolyn Pickel, UC Integrated Pest Management Entomologist Janet Caprile, UC Fruit and Nut Farm Advisor
Tomato	Tim Hartz, UC Vegetable Crops Specialist Gene Miyao, UC Vegetable Crops Farm Advisor
Alfalfa	Pete Goodell, UC Integrated Pest Management Entomologist Rachael Long, UC Field Crops and Pest Management Farm Advisor

Review comments previously submitted via semiannual reports in word tracking and text format.

- *Subtask 2.3 Field Test Workbook*s

Workbook Grower Field Test Reviewers

Winegrape	3/18/10	Brad Kissler and Dale Carlson
Walnut	5/4/10	Brent Barton and Dave Boersma
Tomato	8/24/10	Don Leinfleder and Steve Chaippe

Alfalfa 9/5/10 Dustin Wagner and Rudy Mussi

Review previously comments submitted via semiannual reports.

- *Subtask 2.4 Print/Publish Assessment Workbooks*

Print copies of draft workbooks for use in field test and for use in workshops

Winegrape 3/18/10

Walnut 5/4/10

Tomato 8/24/10

Alfalfa 9/5/10

Publish workbooks.

Workbooks were submitted to UC Agricultural and Natural Resources Publications for review acceptance and publication as an 8000 series publication available free for download. http://ucanr.org/freepubs/docs/"pub number".pdf. The publication citation and ANR publication numbers are:

Prichard, T., P. Verdegaal, L. Schwankl, and R. Smith. Controlling offsite movement of agricultural chemical residues: Winegrapes. Oakland: University of California Agriculture and Natural Resources Publication 8456.

Prichard, T., B. Aegerter, and L. Schwankl. Controlling offsite movement of agricultural chemical residues: Tomatoes. Oakland: University of California Agriculture and Natural Resources Publication 8457.

Prichard, T., L. Schwankl, R. Long, and M. Canevari. Controlling offsite movement of agricultural chemical residues: Alfalfa. Oakland: University of California Agriculture and Natural Resources Publication 8459.

Prichard, T., J. Grant, and L. Schwankl. Controlling offsite movement of agricultural chemical residues: Walnuts. Oakland: University of California Agriculture and Natural Resources Publication 8460.

<u>Task 3 Producer Outreach and Education</u>

Subtask 3.1 Identify target area(s) for implementation. Deliverables: map of subwatershed area, list of crop acreage and current practices, report of baseline year of toxicity testing. Projected date for completion: 01/01/2009. **Subtask 3.2** Reinforce the use of currently available management practices. Deliverables: copies of Coalition publications, copies of agendas from the County Agriculture Commissioner (CAC) and University of California Cooperative Extension (UCCE) management practice meetings. Projected date for completion: 02/01/2011.

Subtask 3.3 Implement self-assessment workbook with workshops for at least 14 producers of each of the four targeted crops in targeted watershed(s). Deliverable: attendance lists from workbook workshops. Projected date for completion: 02/01/2011. **Subtask 3.4** Implement IPM practices. Deliverables: list of practices implemented specific to crop, analysis of practice implementation reasoning. Projected date for completion: 04/01/2011. **Subtask 3.5** Implement experimental IPM practices: Deliverables: list of practices implemented specific to crop, analysis of practice implementation reasoning, analysis of watershed factors for selection, and costs of use and implementation. Projected date for completion: 04/01/2011.

- *Subtask 3.1 Identify Target Areas for Implementation*

<u>Map of Subwatersheds</u>

The Coalition includes parts of Alameda, Contra Costa, Calaveras, San Joaquin, and Stanislaus counties and comprises approximately 2,156,031 acres of which 28% are considered irrigated agriculture (DWR, 2001). The northern border of the Coalition area corresponds to the county line between San Joaquin and Sacramento counties. Although exact acreage is difficult to estimate due to rapidly changing land use, the Coalition area contains approximately 600,000 acres that are considered irrigated agriculture (based on 2001 DWR date). A variety of crops is grown within the Coalition boundaries and different crops are often found in regions with specific microclimate, soil type, and local farming history.

At the initiation of this project, 17 water bodies in the Coalition region required a management plan, including Duck Creek, Littlejohns Creek, Temple Creek, and Lone Tree Creek. These four subwatersheds form a contiguous area on the southeast boundary of the coalition area. Each of these subwatersheds has experienced exceedances in organophosphate pesticide concentrations and Hyalella toxicities, as a proxy for pyrethroid and chlorpyrifos pesticide caused toxicities.

Description of Duck Creek Subwatershed

Duck Creek @ Highway 4 (15,046 irrigated acres) is located just to the east of the city of Stockton. Duck Creek drains a section of southern San Joaquin County between Stockton and the Lone Tree Creek subwatershed. During the summer, flow in the creek is typically low. The creek channel was dredged over several months early in the 2007 irrigation season. The predominant land uses are field crops and irrigated pasture. There is also a large amount of deciduous orchards in this subwatershed. Truck farm/nursery and berry crops are also grown. Figure 3-1 illustrates the land use within the Duck Creek subwatershed area.

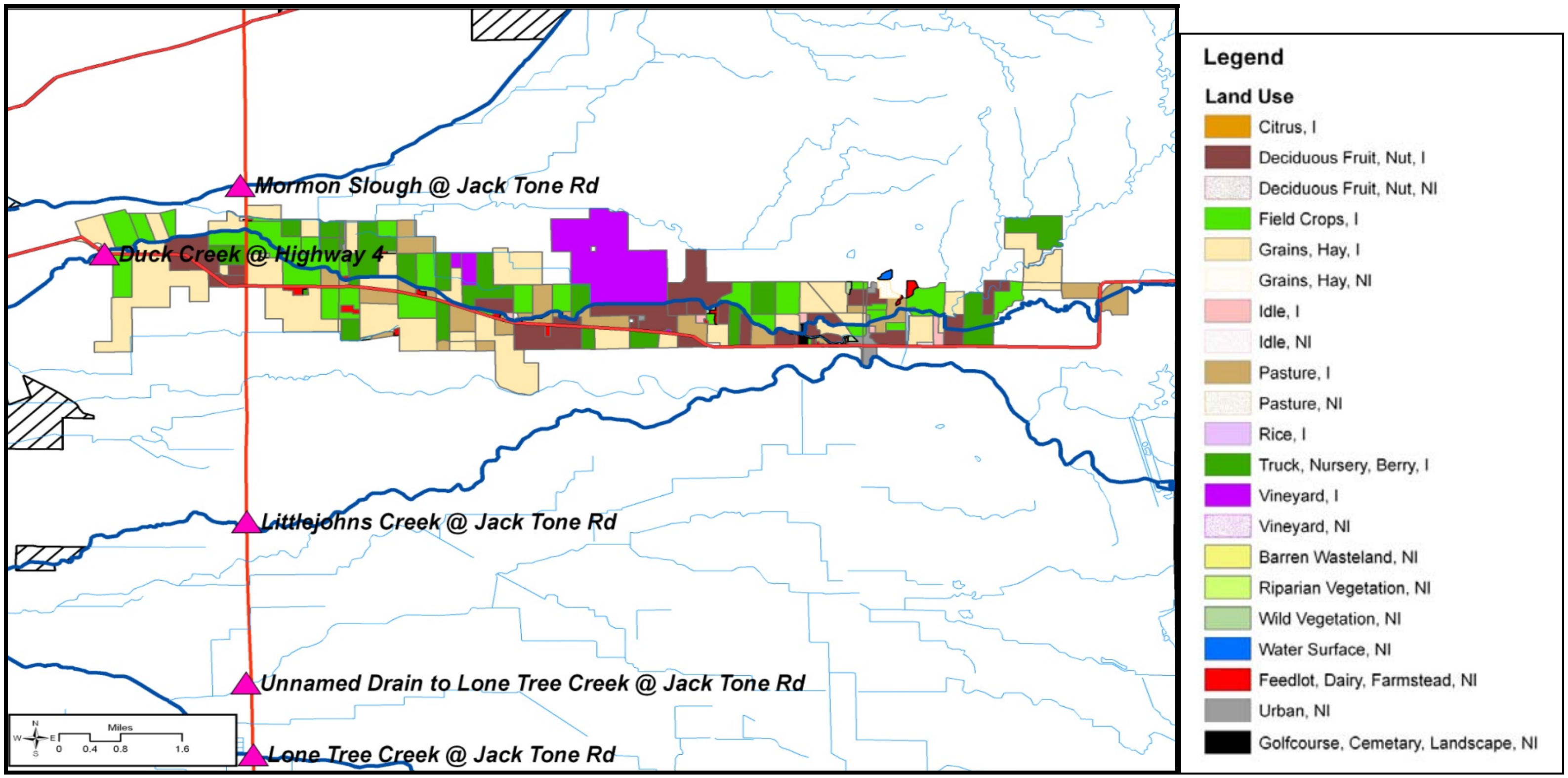

Figure 3-1 Site Subwatershed Map of Land Use for Sample Site at Duck Creek @ Hwy 4

Description of Littlejohns Creek Subwatershed

Littlejohns Creek @ Jack Tone Road (34,050 irrigated acres) subwatershed originates at the western edge of Woodward Reservoir, flowing east through the Farmington Flood Control basin and eventually joins with Lone Tree Creek to form French Camp Slough. The Creek originally flowed intermittently, but summer releases from water storage (from at least five dams) and irrigation return flows have resulted in year round flow. The crops grown in the subwatershed represent all of the major types of agriculture present in the Coalition region including field crops, orchards, grains, and vineyards as well as irrigated pasture (Figure 3-2).

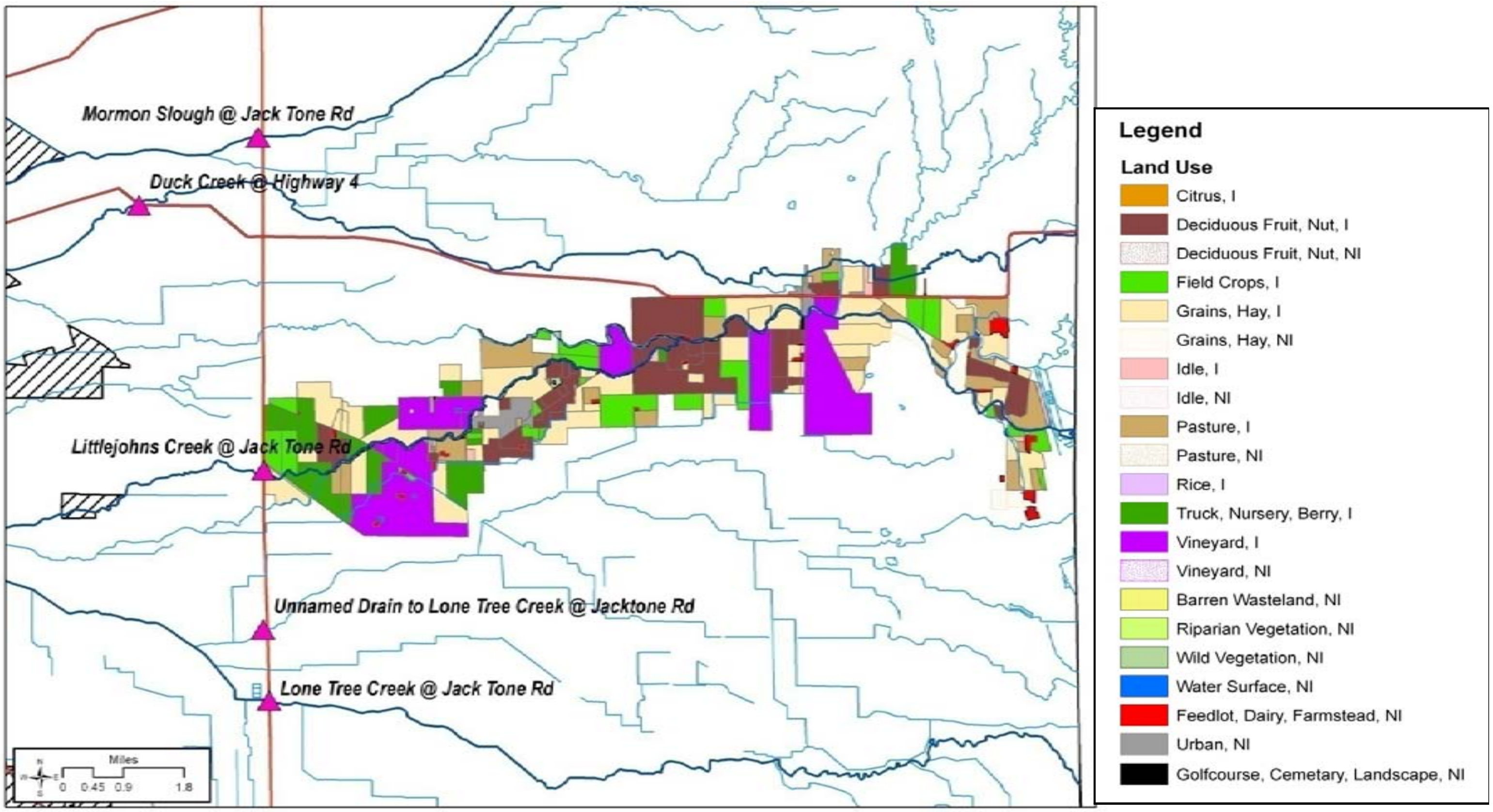

Figure 3-2 Site Subwatershed Map of Land Use for Sample Site at Littlejohns Creek @ Jack Tone Road

Description of Temple Creek Subwatershed

Temple Creek @ Jack Tone Road (29,892 irrigated acres) subwatersheds is located to the north of the Lone Tree Creek subwatershed and south of Littlejohns Creek. The drain forms in the eastern portion of San Joaquin County and flows west eventually joining with Lone Tree Creek just west of Jack Tone Road. Unlike most of the SJCDWQC area, rice is a major crop in the subwatersheds. Agriculture in the Subwatershed also includes deciduous orchards, field crops and grains. Figure 3-3 illustrates the land use within this subwatershed area.

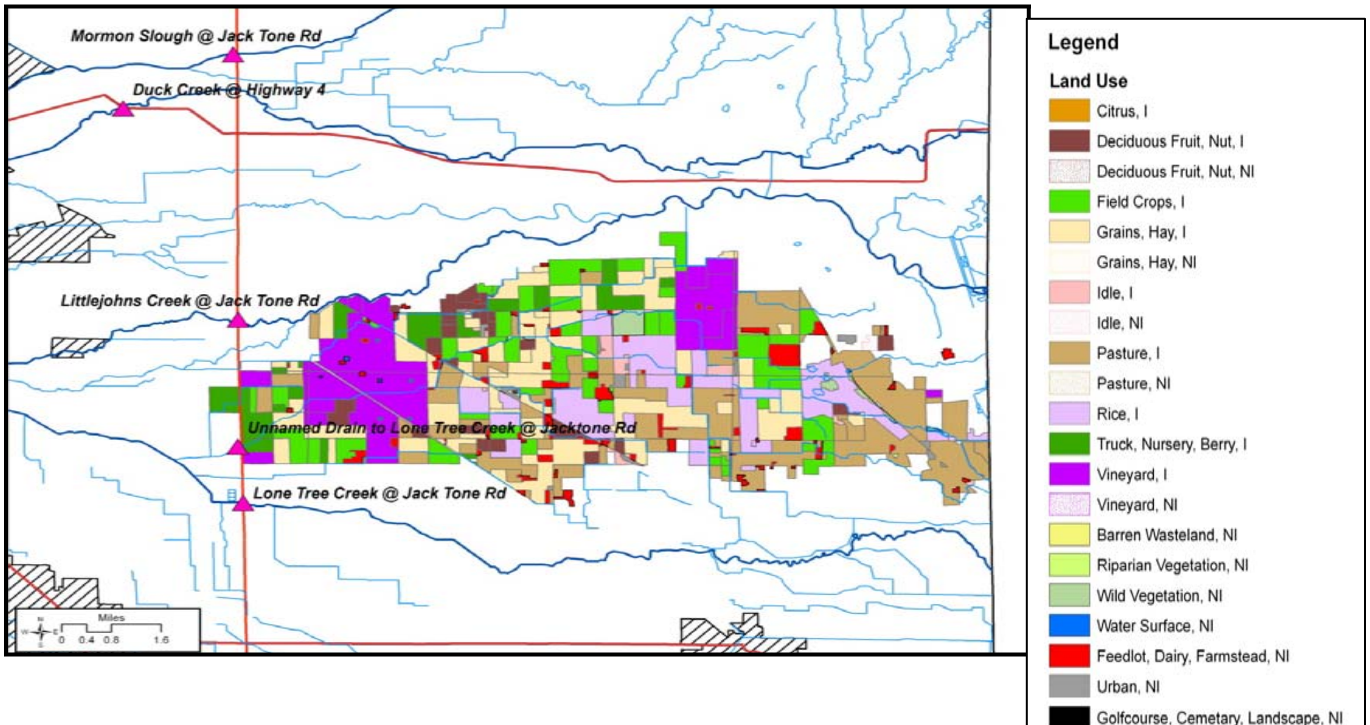

Figure 3-3 Site Subwatershed Map of Land Use for the Temple Creek (Highlighted Points Mark Current Sampling Sites)

Description of Lone Tree Creek Subwatershed

Lone Tree Creek is a 20-mile long modified natural channel originating south of Woodward Reservoir. This ephemeral stream carries natural runoff for the Farmington flood control basin during periods of high flow and is composed mostly of hardpan clay. During the irrigation season Lone Tree Creek carries agricultural supply and return flows to its confluence with Littlejohns Creek.

Lone Tree Creek @ Jack Tone Road is upstream from the French Camp Slough @ Airport Way site and contains 29,232 irrigated acres. This site drains a large portion of the southern SJCDWQC region and joins with Littlejohns Creek downstream eventually forming French Camp Slough which flows through urban areas before emptying into the Delta. The main agricultural land uses upstream are deciduous orchards, field crops, irrigated pastures and dairies. Figure 3-4 illustrates the land use within this subwatershed area.

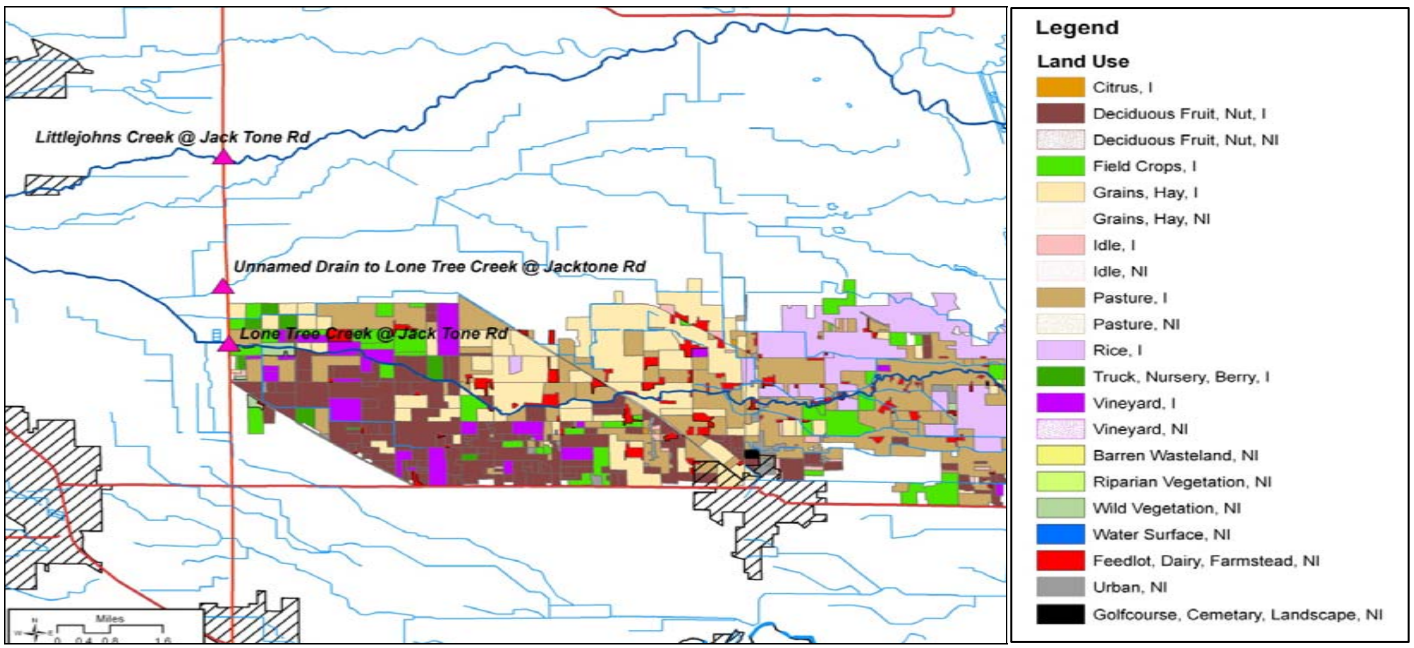

Figure 3-4 Site Subwatershed Map of Land Use for the Lone Tree Creek @ Jack Tone Rd. Sample Site

Crop Acreage

Grant activities addressed four crops within the target area. The target area is four contiguous subwatersheds located on the eastern side of San Joaquin County totaling 108,220 irrigated acres. The crops selected are alfalfa, tomato, walnut and winegrape. The acreage of each crop within each of the five subwatersheds was determined based on the member enrolled acreage by APN (summed per member) per subwatershed (Table 3-1). The four crops represent 40,233 acres or about 59% of the total irrigated crop acreage in the targeted area.

Table 3-1 Acreage by Crop and Subwatershed in Targeted Area

	Alfalfa	**Tomato**	**Walnut**	**Winegrape**	**Total Target Area (four crops)**	**All Irrigated Crop Acres**
Duck Creek	1,719	5,234	5,291	1,232	13,046	15,046
Littlejohns Creek	1,109	4,538	3,757	3,204	12,608	34,050
Lone Tree Creek	2,032	0	750	542	3,324	29,232
Temple Creek	2,215	4,029	2,307	2,275	10,826	29,892
Target Area Total	7,075	13,800	12,106	7,252	40,233	108,220

Report of Baseline Year Toxicity Testing

Water column samples were collected monthly during the project period while sediment samples were collected twice per year as per the Coalition’s Monitoring Plan. The 2008 year is the best time period to use as a baseline in the targeted area. This is due to a change in the Irrigated Lands Regulatory Program sampling schedule requiring more samples be collected going forward from 2007. The same sample schedule was followed in 2008 and 2010 for water column and sediment samples. During the baseline year (2008) there were 14 chlorpyrifos exceedances in the target area averaging 1.95 µg/L (Table 3-2). Malathion and diazinon standards were exceeded a single time each at concentration of 0.22 and 0.2 µg/L respectively. Hyalella toxicity occurred three times during 2008 in the target area with an average toxicity of 52%.

Table 3-2 Baseline Year (2008) Water Column Water Quality Exceedances and Average Concentration of Exceedances of Chlorpyrifos, Diazinon, and Malathion. Sediment Sample Toxicity and Average Survival Percentage of Hyalella in 2008.

		Total Targeted Area 2008
Water Column Exceedances		
chlorpyrifos	Number of Exceedances	14
	Average exceedance Concentration µg/L	1.95
diazinon	Number of Exceedances	1
	Average exceedance Concentration µg/L	0.2
malathion	Number of Exceedances	1
	Average exceedance Concentration µg/L	0.22
Sediment Hyalella Toxicity*		
Hyalella Toxicity	Number of Toxicities	3**
	Average Percent Survival	52

*Hyalella Toxicity if survival below 80%.

** 2008 presumed to be pyrethroid or chlorpyrifos toxicity

<u>Baseline Year Management Practices in Use within the Target Area</u>

Management practices in use in the 2008 season were evaluated in January-March 2009 based on survey responses from growers in the following high priority subwatersheds which make up the targeted area:

1. Duck Creek @ Hwy 4
2. Littlejohns Creek @ Jack Tone Rd
3. Temple Creek @ Jack Tone Rd
4. Lone Tree Creek @ Jack Tone Rd

Lone Tree Creek was added to the target area in 2009, consequently the survey of currently implemented practices for the year 2009 was conducted in January-March 2010.

Duck Creek

59% of the Duck Creek subwatershed has direct drainage to the waterway (8,904 of 15,046 acres) based on GIS land use layer analysis. 59% of the parcels with direct drainage are enrolled in the Coalition (5,254 acres) and 35 members representing 4,978 acres filled out surveys with current management practice information.

Of the members who filled out the surveys, 43% of the acreage had tailwater runoff and 90% of the acreage had stormwater runoff. The most common management practice currently implemented by growers in Duck Creek is using less of pesticides of concern including chlorpyrifos (37% of the acreage, Table 3-3). Additional management practices include reduction of runoff water using irrigation management, use of center grass rows, grass waterways or grass filter strips and installation of micro sprinkler or drip irrigation. A small percentage of grower acreage (5%) have installed retention ponds, holding basins or return systems. In 2008, approximately half of the direct drainage acreage enrolled in the Coalition used one or more management practice specific to runoff management and/or pesticide application management.

Littlejohns Creek

15% of the Littlejohns Creek subwatershed was determined to have direct drainage (5,277 of 34,050 acres) based on GIS land use layers. 90% of the parcels with direct drainage are enrolled in the Coalition (4,739 acres) and 16 members representing 2,796 acres filled out surveys with current management practice information.

Survey results indicate that 26% of the acres had tailwater runoff and 72% of the acres had stormwater runoff. The most common management practice currently implemented by growers in the Littlejohns Creek subwatershed was reducing runoff water volumes through irrigation management (29% of the acres) followed closely by use of center grass rows, grass waterways or grass filter strips (26% of the acres) and reducing the use of pesticide types found in exceedance (25% of the acres, Table 3-3). Additionally, 20% of the acres have sprinklers or micro irrigation when an option. In 2009, approximately 57% of the direct drainage acreage enrolled in the Coalition (2,692 of 4,739 acres) recorded the current implementation of one or more management practices specific to runoff management and/or pesticide application management.

Temple Creek

65% of the Temple Creek subwatershed was determined to have direct drainage (19,417 of 29,892 acres) based on GIS land use layers. 41% of the parcels with direct drainage are enrolled in the Coalition (7,994) and 34 members representing 6,463 acres filled out surveys with current management practice information.

Of the members who filled out the surveys, 32% of their acres had tailwater runoff and 77% recorded that they have stormwater runoff. The most common currently implemented management practice currently implemented by growers in the Temple Creek subwatershed is using less pesticides including chlorpyrifos (27% of the acres), followed closely by installing sprinkler or microirrigation (26% of the acres) and reducing runoff water volumes through irrigation management (20%, Table 3-3). Additional management practices include use of center grass rows, grass waterways or grass filter strips (15%of the acres), and installation of a retention pond, holding basin or return system (12% of the acres). In 2008, a majority of the direct drainage acreage (68%) enrolled in the Coalition recorded the implementation of one or more management practices specific to runoff management and/or pesticide application management.

Lone Tree Creek

50% of the Lone Tree Creek subwatershed was determined to have direct drainage (14,583 of 29,232 acres) based on GIS land use layers. 31% of the parcels with direct drainage are enrolled in the Coalition (4,586) and 43 members representing 3,742 acres filled out surveys with current management practice information.

Of the members who did record their current management practices, 42% of the acreage had tail water runoff and 65% of the acres have stormwater runoff. The most common management practice currently implemented by growers in Lone Tree Creek is using less of pesticides of concern including chlorpyrifos (30% of the acres) followed closely by reducing runoff water volumes through irrigation management (24% of the acres, Table 3-3). Additional management practices include use of center grass rows, grass waterways or grass filter strips and installation of micro sprinkler or drip irrigation. A small percentage of grower acreage (9%) has installed retention ponds, holding basins or return systems and 2% of the acreage is treated with Polyacrylamide (PAM). In 2008, a majority of the direct drainage acreage enrolled in the Coalition recorded the current use one or more management practices specific to runoff management and/or pesticide application management (68%).

Entire Target Area

47% of the Lone Tree Creek subwatershed was determined to have direct drainage (48,181 of 108,220 acres) based on GIS land use layers. 55% of the parcels with direct drainage are enrolled in the Coalition (22,573) and 147 members representing 17,979 acres filled out surveys with current management practice information

Of the members who filled out the surveys, 36% of their acres had tailwater runoff and 76% recorded that they have stormwater runoff. The most common management practice currently implemented by growers in the target area is using less of pesticides of concern including chlorpyrifos (30% of the acres) followed closely by reducing runoff water volumes through irrigation management (24% of the acres, Table 3-3). Additional management practices include use of center grass rows, grass waterways or grass filter strips (19% of the acres)and installation of micro sprinkler or drip irrigation(20% of the acres). A small percentage of grower acreage (7%) has installed retention ponds, holding basins or return systems and 2% of the acreage is treated with Polyacrylamide (PAM). In 2008, a majority of the direct drainage acreage enrolled in the Coalition recorded the current use one or more management practices specific to runoff management and/or pesticide application management (68%).

Table 3-3 Management Practices in Use During 2008 (2009 in Littlejohns Creek) in the Target Area as a Percentage of Acres Reported in the Current Management Practice Survey

Area	Retention pond / Return system	Pressurized Irrigation System	Reduce Runoff Volumes	Reduced Use of Pesticides in Exceedance	Use of Grass Centers or Vegetated Strips
Duck Creek	5	18	23	37	17
Littlejohns Creek	0	20	29	25	26
Temple Creek	12	26	20	27	15
Lone Tree Creek	9	16	24	30	19
Entire Target Area	7	20	24	30	19

- *Subtask 3.2 Reinforce the Use of Currently Available Management Practices*

About sixty grower outreach meetings were conducted over the term of this grant. They are summarized in Table 1 in Appendix I. The meeting announcements, agendas and attendance were submitted as items for review in the semi annual reports. The table contains a list of outreach meetings, dates and attendance numbers at which presentations were made to reinforce currently available management practices to reduce offsite movement of agricultural pesticide residues. Attendees totaled 6564 from 2008 through 2011.

- *Subtask 3.3 Implement Self-Assessment Workbooks with Workshops for Producers of Each of the Targeted Crops*

A grower meeting was held for each of the targeted commodities for growers in the target area (Table 3-4).

Table 3-4 Self-Assessment Workshops Held in Target Area

Crop	Date	Invited	Attendance
Winegrape	3/25/10	14	16
Walnut	5/10/10	65	21
Tomato	9/29/10	15	8
Alfalfa	7/6/10	24	14

Additionally, growers who did not attend the workshops were mailed two copies of the workbook. One for the grower and one for the grower's pest control advisor.

- *Subtask 3.4 Implement Management Practices.*

<u>Management Practices by Subwatershed within the Target Area</u>

Grower management practice meetings were held in the targeted area subwatersheds in 2009 with the exception or Littlejohns Creek subwatershed which was in 2010. Growers were requested to fill out a survey listing their current management practices to control offsite movement of pesticide residues. After the management practice presentation describing the extent of the water quality exceedances and practices that can mitigate offsite movement, they were encouraged to implement practices during the next season. Finally they were requested to indicate on the survey any practices they intended to implement in the next season. A follow-up survey was conducted after the next season to determine if in fact the practiced were implemented.

Duck Creek

21% of acres represented by the growers who filled out a survey indicated that they would not implement any additional practices in 2009, and are not included in Table 3-5. Of the growers that indicated that they intended to implement additional practices in 2009, 39% of the total acres intend to reduce applications of pesticides (Table 3-5). Growers intend to place vegetation (center grass rows, grass waterways or grass filter strips) to reduce both water and sediment runoff on thirty percent of their acreage. Additional irrigation management practices to reduce runoff will be implemented on 17% of the acres, 8% of acres will have the installation of sprinkler or micro irrigation, and retention ponds, holding basins or tailwater return systems will be installed on 2% of acres. Growers on less than one percent indicated they do not intend to change their current practices.

Growers who filled out surveys indicating that they intended to implement additional management practices were contacted during the spring of 2010 with follow up surveys. The Coalition has followed up with growers and has received surveys back from 100% of those contacted. One grower indicated that they intended to implement additional practices in 2010, and they were contacted again in winter of 2010. The results of those surveys indicate that additional management practices were implemented across 2,425 member acres with direct drainage to Duck Creek. Of the management practices implemented, the most common strategy (applied to 48% of the acres, Table 3-6) was to reduce use of the pesticides of concern. Using center grass rows, grass waterways or grass filter strips, reducing runoff water volume using irrigation management, and installation of sprinkler or microirrigation were implemented on 26%, 15%, and 11% of the acres, respectively.

Littlejohns Creek

Growers indicated that they intended to implement additional practices in 2010 including irrigation management practices to reduce water runoff (32% of acres), reduce application of pesticides of concern such as chlorpyrifos (29% of acres) and intend to use center grass rows, grass waterways or grass filter strips (28% of acres, Table 3-5). Additionally, 10% of acres will have micro sprinkler or drip irrigation installed and about 1% of acres intend to install a retention pond, holding basin or return system.

Final results of the follow up surveys indicate that additional management practices were implemented across 2566 acres with direct drainage to Littlejohns Creek. Implemented practices include reducing runoff water volumes using irrigation management (34% of acres, Table 3-6), reducing use of pesticides of concern (28% of acres), using center grass rows, grass waterways or grass filter strips (25% of acres), and installation of sprinkler or microirrigation (13% of acres).

Temple Creek

Growers farming 10% of the acres indicated they would not implement any additional practices in 2009. Of the growers that indicated that they intended to implement additional practices in 2009, reduced pesticide use was to occur on 31% of the total acreage (Table 3-5). Installation of micro sprinklers or drip irrigation was to occur on 25% of the acres, implementation of irrigation management was to occur on 18% of acres, installation of a retention pond, holding basin or return system was to occur on 12% of the acres, and center grass rows, grass waterways or grass filter strips were to be placed on 11% of the acres.

Final results of the follow up surveys indicate that additional management practices were implemented on 3,934 member acres with direct drainage to Lone Tree Creek (4,649 acres were reported in the 2010 MPUR). Thirty-seven percent of the acres had the installation of sprinklers or micro irrigation (Table 3-6), 31% of the acres had reduced pesticide applications, and 24% of the acres had reduced runoff water volumes due to irrigation management. The remaining eight percent of the acres had the installation of retention pond, holding basin, or return systems, or using center grass rows, grass waterways or grass filter strips.

Lone Tree Creek

Growers with 12% of the acres indicated that they would not implement any additional practices in 2009. Of the growers that indicated that they intended to implement additional practices in 2009, reducing applications of pesticides was to occur on 41% of the acres (Table 3-5). Irrigation management practices to reduce runoff was to be implemented on 28% of the total acres, micro sprinkler or drip irrigation was to be installed on 13% of the acres, center grass rows, grass waterways or grass filter strips were to be installed on 10% of the acres, and installation of a retention pond, holding basin or return system was to occur on 8% of the acres.

Final results of the follow up surveys indicate that additional management practices were implemented across 1,923 acres that have direct drainage to Lone Tree Creek. The most common practices implemented were reducing pesticide use, installing sprinklers or microirrigation, and managing irrigation to reduce runoff volumes(Table 3-6). Implementation of all practices resulted in 91% of acreage in the subwatershed having with new practices relative to 2009-2010. Other practices included installing retention ponds/ holding basins/return systems (7% of acres implemented) and using center grass rows, grass waterways or grass filter strips (2% of acres implemented).

<u>Entire Target Area (All Four Subwatersheds)</u>

11% of acres represented by the growers who filled out a survey indicated that they would not implement any additional practices in 2009 (2010 in Littlejohns Creek subwatershed), and are not included in Table 3-5. Of the growers that indicated that they intended to implement additional practices in 2009, 35% of the total acres intend to reduce applications of pesticides (Table 3-5). Growers intend to place vegetation (center grass rows, grass waterways or grass filter strips) to reduce both water and sediment runoff on twenty percent of their acreage. Additional irrigation management practices to reduce runoff will be implemented on 22% of the acres. Fifteen percent of acres will have the installation of sprinkler or microirrigation, while 6 % of the acres plan retention ponds, holding basins or tailwater return systems.

Growers who filled out surveys indicating that they intended to implement additional management practices were contacted during the spring of 2010 (2011 in Littlejohns subwatershed) with follow up surveys. The Coalition has followed up with growers and has received surveys back from 100% of those contacted. The results of those surveys indicate that additional management practices were implemented across 11,563 member acres with direct drainage to Duck Creek. Of the management practices implemented, the most common strategy (applied to 35% of the acres, Table 3-6) was to reduce use of the pesticides of concern. Reducing runoff water volume using irrigation management, installation of sprinkler or microirrigation, and using center grass rows, grass waterways or grass filter strips, were implemented on 26%, 23%, and 14% of the acres, respectively.

Table 3-5 Management Practices Planned to Be Implemented in 2009 (2010 in Littlejohns Creek) in the Target Area as a Percentage of Acres Reported in the Management Practice Survey

Area	Retention pond / Return system	Pressurized Irrigation System	Reduce Runoff Volumes	Reduced Use of Pesticides in Exceedance	Use of Grass Centers or Vegetated Strips
Duck Creek	2	8	17	39	30
Littlejohns Creek	1	10	32	29	28
Temple Creek	12	29	18	31	13
Lone Tree Creek	8	13	20	41	10
Entire Target Area	6	15	22	35	20

Table 3-6 Management Practices Implemented in 2009 (2010 in Littlejohns Creek) in the Target Area as a Percentage of Acres Reported in the Management Practice Follow-up Survey

Area	Retention pond / Return system	Pressurized Irrigation System	Reduce Runoff Volumes	Reduced Use of Pesticides in Exceedance	Use of Grass Centers or Vegetated Strips
Duck Creek	0	11	15	48	26
Littlejohns Creek	0	13	34	28	25
Temple Creek	4	37	24	31	4
Lone Tree Creek	7	30	29	32	2
Entire Target Area	3	23	26	35	14

Analysis of Management Practice Implementation

Suitability of Management Practices

All management practices used to prevent offsite movement of pesticides are not suited for all field situations. Some management practices are limited to the type of irrigation system whether that be surface gravity irrigation or pressurized irrigation (sprinkler or microirrigation). Table 3-7 indicates the suitability of management practices by irrigation and crop.

Table 3-7 Management Practice Suitability by Irrigation System and Crop

Management Practice	Surface Irrigation	Pressurized Irrigation	Winegrape	Walnut	Tomato	Alfalfa
Install pressurized irrigation	X		X	X	X	X
Install holding basin or return system	X		X	X	X	X
Reduce runoff using irrigation management	X	X	X	X	X	X
Reduce use of pesticides of concern	X	X	X	X	X	X
Use grass rows		X	X	X		
Use grass water ways or filter strips	X		X	X	X	X

Retention Pond / Return Systems

The Temple Creek and Lone Tree Creek sub watersheds have the highest level of current practice implementation at 12% and 9% respectively. Additionally, both watersheds have the highest level of planned and implemented acreage. These two subwatersheds have a large dairy presence which requires retention/recycling ponds on all lands to which lagoon waters are applied. Dairymen also commonly grow both field and orchard crops. Many have become accustomed to the benefits of recycling ponds and have installed them on acreage not under the containment regulations.

Conversion to Pressurize Irrigation Systems

Current practices reveal a relatively high (and consistent between the subwatersheds) percentage of the acreage is currently uses pressurized irrigation systems (20% of the target area). This acreage represents primarily the vineyard and orchard acreage. Tomato acreage is moving toward microirrigation while most orchards and vineyards currently use pressurized irrigation systems. It is possible to use pressurized irrigation in alfalfa production; however current economics do not support conversion from surface irrigation systems. On a target area basis, there were more implemented acres than planned during the measured period. The trend it to change crops from field/vegetable crops to orchard and vineyard crops which utilize pressurized systems. Additionally, there is some conversions from surface to pressurized systems in tomato.

Reduced Runoff Volumes

Current practices reveal a relatively high (and consistent between the subwatersheds) percentage of the acreage is currently uses pressurized irrigation systems (24% of the target area). The planned and actual implementation of this practice is similar at 22% and 26% respectively. It is always the goal of growers to reduce runoff volumes for a variety of reasons, including maximizing production and improving plant health, and minimizing water/pumping costs. Management practices which aid in this goal are runoff recycling systems, irrigation scheduling, irrigation management, and converting to pressurized systems.

Reduced Use of Pesticides in Exceedance

Current practices reveal a relatively high (and consistent between the subwatersheds) percentage of the acreage is currently attempting to reduce the use of pesticides found in exceedance. See Table 3-2 for pesticides found in exceedance in the target area in 2008. This practice had the highest use of all current management practices at 30% of the acreage. It should be pointed out that the coalition outreach effort has focused on the subwatersheds in the target area since 2006; therefore growers were aware of the water quality exceedances and the need to reduce them. Planned implementation and actual implementation of this practice were the same at 35 % of the acreage.

Use of Grass Centers or Vegetative Strips

The practice using of grass centers is restricted to vineyard and orchard crops while vegetative filter strips can be used on all crops. The current use of this practice represents 19% of the acreage. Planned implementation of this practice was 20 % of the acreage however only 14% of the acreage was actually implemented. In talking with growers who attempted to install vegetative strips at the field tail using surface irrigation the most common complaint was the difficulty of the vegetative strip establishment. This problem may be related to the time of year when establishment is attempted and the vegetative plant species used.

- *Subtask 3.5 Implement Experimental Management Practices*

Experimental management practices, like known practices, are those that focus on preventing pesticides and residues from entering surface waters. Unlike management practices that are known to reduce the risk of offsite movement, experimental management practices those that are either not proven to be effective or practical. These practices were implemented in grower fields and carefully measured for effectiveness and practicality Table 3-8 indicates the suitability of these experimental management practices by irrigation system and crop. All but one of the evaluations was conducted on one of the four target crops. A single evaluation was performed on a corn fields. The reasoning for evaluating this management practice was simply that any use of chlorpyrifos in surface irrigated crops may lead to increased exceedances. Since the goal of the project was to reduce exceedances the practice of insecticide active ingredient and formulation substitution along with the soil and irrigation management practice was appropriate. During the period 2005 through 2010, 21,205 pounds of chlorpyrifos active ingredient were applied to corn while only 5,360 pounds of active ingredient were applied to alfalfa. Chlorpyrifos Coalition matching funds were used to conduct this evaluation as a part of the larger role in reducing exceedances. Each of these experimental management practice evaluations were conducted by Terry Prichard. This is the first reporting of evaluation results; as such none have been published.

Table 3-8 Experimental Management Practice Suitability by Irrigation System and Crop

Management Practice		**Surface Irrigation**	**Pressurized Irrigation**	**Winegrape**	**Walnut**	**Tomato**	**Alfalfa**	**Corn**
Orchard floor management								
	Vertical tillage	X	X	X	X			
	Cover crop	X	X	X	X			
Use reduced risk pesticides								
	Pesticide formulation. Pesticide class OP vs pyrethroid. Soil type and irrigation management	X						X
	Pheromone	X	X		X			
Runoff water treatment								
	Landguard OP-A	X		X	X	X	X	X
	PAM	X		X	X	X	X	X

The Use of Vertical Tillage Implements in Orchards and Vineyards to Improve Water Infiltration During Stormwater Events Winter 2009– Spring 2011

Walnut Orchard Floor Management Practices that Influence Runoff Volumes and Pesticide Residuals Contained in the Runoff Waters in the Temple Creek Subwatershed Winter 2009-Spring 2010.

Objective: Compare the efficacy of three different orchard floor management practices for reducing the volume of runoff waters and the offsite movement of pesticide residues.

Orchard and vineyard production typically requires many passes by equipment for the purposes of insect/weed control and in the case of this orchard summer weed mowing. Additionally, harvest in tree crops requires shaking, nut sweeping and nut pickup. In vineyards, mechanical harvester and fruit gondola and tractor combinations are used. Each of these operations contributes to soil compaction, which limits water infiltration rates and increases the chance of runoff during winter storms. To improve soil infiltration rates and decrease runoff, a planted cover crop and tillage using a "vertical tillage" machine (Aerway) were compared singly and together to an untreated control consisting of no tillage or planting. Three replications of each treatment were measured. The grass cover crop was planted November 3rd 2009. The vertical tillage was equipment was used just prior to planting in two passes per center, which covered the entire area that was not strip sprayed with simazine and diuron. The orchard was a mature 22 x 18 ft spacing planted on a Madera Loam soil. The spray strips were 6 ft wide, representing 27% of the land surface. The trees are planted on berms which channel runoff waters to the measurement flumes. Flumes were placed in the lower end of each measured check and instrumented with pressure transducers interfaced to a micro logger to measure runoff over time. A series of storms in mid January and in late February provided for rainfall which infiltrated into the soil in all treatments. The cover crop was well established by the late February storms. During the spring, rainfall events were spaced at about 7-10 day intervals and in any event no runoff occurred until a storm of increased intensity occurred 2/27/10. During this rainfall event runoff volumes were measured from each treatment. Results are presented as the percentage reduced runoff volume compared to the untreated control (Table 3-9)

Table 3-9. Tillage and Cover Crop Runoff Reduction Evaluation 1

Treatment	**Runoff reduction (%) from UTC**
Untreated control	
Tillage	20
Cover crop	25
Tillage + Cover crop	48

Results

The cover crop treatment provided a better reduction in runoff volumes than the vertical tillage treatment at a 25% reduction, 5 % more than the tillage alone. The combination of vertical tillage and the use of the cover crop provided the greatest reduction at 48%.

<u>Walnut Orchard Floor Management Practices that Influence Runoff Volumes and Pesticide Residuals Contained in the Runoff Waters Winter 2009–Spring 2011</u>

Objective: Compare the efficacy of three different orchard floor management practices as to their ability to reduce the volume of runoff waters and the offsite movement of pesticide residues.

To improve soil infiltration rates and decrease stormwater runoff a planted cover crop and tillage using “vertical tillage” (Aerway) machine were compared to an untreated control consisting of no tillage or planting. The Aerway tillage machine is shown in Figure 3-4. The mixed grass and legume cover crop was planted using a Great Plains no-till drill November 17th 2010. The vertical tillage equipment was used in two passes per center, which covered the entire area that was not strip sprayed. The orchard is a mature 25x 25 ft spacing planted on Archerdale clay loam soil. The spray strips were 6 ft wide, representing 24% of the land surface and treated with simazine and diuron. Flumes were placed in the lower end of each check measured and instrumented with pressure transducers interfaced to a micro logger to measure runoff over time.

Three replications of each treatment were measured. A series of storms in mid-to late November and through early December provided rainfall which infiltrated into the soil in all treatments. At that time, the cover crop was in the seedling stage and not well established. Rainfall occurring December 28th was of high intensity following rain a few days prior (December 25th), resulting in a large volume of runoff. Measurements of runoff were made until the measuring flume capacity was reached. Results are presented as the percentage reduced runoff volume compared to the untreated control (Table 3-10). Rainfall again causing significant runoff occurred February 17$^{th.}$ A rainfall event as the March 20th event occurred causing runoff from all treatments. Results are presented as the percentage reduced runoff volume compared to the untreated control (Table 3-9)

The First Measured Runoff Event

The cover crop was not well established and since a no-till drill was used, resulting in little soil disturbance in planting, little runoff reduction was noticed. The vertical tillage reduced the runoff by 40% over the untreated control. The combination of the vertical tillage and cover crop was about the same, indicating the cover had little impact during this runoff event. Even though runoff could not be measured for the entire event, differences between treatments existed for 80% of the runoff total runoff time.

The Second Measured Runoff Event

After the first runoff event many more high intensity storms occurred before runoff was again measured on 3/20/11. The goal was to wait until the cover crop was well established to measure any differences. With little surface protection the vertical tillage treatments in this clay soil melted back together forming a crusted soil surface impeding infiltration. At this measured runoff event the opposite results from the first event occurred. The cover crop reduced runoff over the control both with and without tillage.

Table 3-10 Tillage and Cover Crop Runoff Reduction Evaluation 2

Treatment	**Runoff reduction (%) from UTC**	
	12/28/10	**3/20/11**
Untreated control		
Tillage	40	10
Cover crop	5	35
Tillage + Cover crop	42	38

These results indicate that early in the storm season vertical tillage was able to reduce runoff due to the physical disruption of soil crusts and compaction, while the cover crop was ineffective at this time. Later in the season after good cover crop development, the cover crop was the most effective in reducing runoff due to soil surface protection from rainfall forces and its ability to use moisture from the soil between rainfall events, providing room for soil storage.

Costs of the Vertical Tillage and Cover Crop in both Walnut Orchard Floor Management Practice Evaluations

Since both vertical tillage and cover crop planting require the equipment and a tractor, the best way to compare the practice costs is to use a custom operator rather than to attempt to use purchase price, depreciation, fuel and labor costs. Planting of the cover including seed was $26.00 per acre while vertical tillage was $8.50 per acre; the combination of practices was $34.50. These costs are on an entire field area basis. Two passes of each piece of equipment were necessary per row to cover the non-strip sprayed area.

Figure 3-4 Aerway Vertical Tillage Equipment

<u>Use of Pyrethroid as Alternative to Chlorpyrifos in Corn Seeding to Reduce Residues in Runoff Waters Under Different Soil and Irrigation Management Conditions Summer 2009</u>

Background

A previous study conducted in 2008, the practice of applying chlorpyrifos granules with corn seed followed by irrigation resulted in runoff waters containing residues measuring many times the water quality trigger or exceedance value of 0.015 µg/L. The evaluation was conducted in corn planted to dry beds in a clay loam soil then immediately furrow irrigated. The practice of planting into dry beds is common in clayey soils since pre-irrigation would result in soils too wet in the furrow to plant while waiting risks too dry a seedbed to ensure uniform germination. In medium to coarse textured soils, the typical method of corn culture is to pre-irrigate the bedded field, then when dry enough for field access, plant the corn to moisture along with the addition of chlorpyrifos granules. The first crop irrigation follows by as much as 30 - 40 days after planting. This method provides for a more compact bed which is more resistant to water flux into and out of the bed when compared to the dry beds. Alternative practices are the use of liquid chlorpyrifos injected into the seed line with the starter fertilizer rather than granules at planting or the use of pyrethroid granular insecticides.

Objectives

- This study is designed to evaluate chlorpyrifos and permethrin and application practices in corn production across different soil characteristics that can contribute to or reduce offsite movement of residues in surface irrigation runoff flows.
- Compare the use of Lorsban 4-E and Lorsban 15G applied at equal rates (a.i.) by measuring the concentration of residues in runoff waters from application in dry and pre-irrigated beds.
- Evaluate the effect of soil surface texture by measuring the concentration of residues in runoff waters from fields of different texture using pre-irrigated beds.
- Compare the use of Pounce 1.5G a pyrethroid, to the organophosphates in objective 1.

Site and Field Descriptions

The study was conducted in three cornfields on the east side of the San Joaquin Valley in San Joaquin County. All three soils were fan remnants of alluvial plains which varied in surface soil texture. The fields are designated as site 1 through 3. A particle size analysis of the soil collected from each site is listed in Table 3-11.

Table 3-11. Surface Soil Particle Size Analysis

	Percent Sand	Percent Silt	Percent Clay	Textural Class
Site 1	35	29	36	clay loam
Site 2	72	18	10	sandy loam
Site 3	47	26	27	sandy clay loam

Site 1

The 27-acre corn field is located east of Stockton in San Joaquin County in the Temple Creek subwatershed. The soil is mapped as a of Archerdale clay loam. This site was the dry bed treatment consisting of a 60-inch bed with two planted rows per bed. The ground was worked up in the spring and beds formed from dry soil, which consisted of various sized clods resulting in a very porous bed.

Insecticide Application/Planting

The corn planting and insecticide application were performed in a single operation into the seed row of the dry bed. Twelve rows were planted with each formulation.

Irrigations

Irrigation run length was 930 feet. The first irrigation (May 18) proceeded 7 days after planting using furrow irrigation. The second crop irrigation (June 23) was applied 36 days after the first. The irrigation water source was Littlejohns Creek.

Site 2

The 43-acre field was located south of Site 1 in San Joaquin County in the Temple Creek subwatershed and mapped as a Madera sandy loam. A single row of corn was planted on the per-irrigated 30-inch beds. The soil was worked up, beds formed, then followed by the pre-irrigation.

Insecticide Application/Planting

The corn planting and insecticide application was performed in a single operation into the seed row of the moist bed on June 11. Twelve rows were planted with each formulation.

Irrigations

Irrigation run length was about 2,000 feet. The field was pre-irrigated using furrow irrigation prior to the June 11 planting and insecticide application. The first crop irrigation occurred (July 12) 31 days after planting with the second 15 day later on July 27. The irrigation water source was from a deep well.

Site 3

The 53-acre field located near Escalon in San Joaquin County in the Temple Creek subwatershed and mapped as a Montpellier sandy loam; however, significant surface soil was moved during the land leveling process exposing a layer of soil higher in clay content. The collected surface (0-6 inches) soil sample found the texture to be a sandy clay loam. A single row of corn was planted on the per-irrigated 30-inch beds. The soil was worked up, beds formed, then followed by the pre-irrigation.

Insecticide Application/Planting

The corn planting and insecticide application was performed in a single operation into the seed row of the moist bed on May 26. Twelve rows were planted with each formulation.

Irrigations

Irrigation run length was about 1,300 feet. The first crop irrigation occurred (June 25) 30 days after planting using furrow irrigation with the second 21 days later on July 16. The irrigation water source pumped groundwater.

Insecticide Application

Chlorpyrifos, as Lorsban 4E and 15G, and was applied at the rate of 1.3 lb per acre active ingredient in each treatment and site. Permethrin, as Pounce 1.5G was applied at the rate of 0.13 lb per acre active ingredient in each treatment and site. The granular insecticides were metered from a dispenser into the planter shoe, as was the seed. The 4E formulation was tank mixed with the liquid fertilizer then dispensed into the seed line at planting. Application dates were: Site 1 - 5/11/09; Site 2 - 6/11/09; and Site 3 - 5/26/09.

Water sampling

Irrigation inflow water was collected from the head ditch at each irrigation and site. Four 1L samples were collected at equal time intervals during the irrigation. A single composite sample was created from the time-based samples with each sample contributing equal volume to the composite. Runoff water was collected in a furrow representing each formulation at each site and irrigation. Samples were collected in the same fashion as the inflow water. Runoff water was collected in the furrow 30 feet upstream from the field end to prevent adjacent furrow discharge from mingling with the treatment furrow and to avoid any potential over application that may have occurred at the fields end. A duplicate of the composite sample and two blanks were analyzed for chlorpyrifos content. Soil sediment samples were collected from the furrow bottom at the same location as the water samples.

Sample Storage and Analysis

The composite inflow water and runoff water samples were collected in 1-Liter amber bottles stored on wet ice. The water samples were delivered to APPL Labs in Fresno via courier within

24 hours of collection. Samples were analyzed for chlorpyrifos content using EPA 8141A procedure and EPA 8081A for permethrin content.

Results and Discussion

Site 1

Concentrations of chlorpyrifos were found in excess of the water quality standard in the irrigation runoff from both irrigations and both formulations (Table 3-12). The 4E formulation resulted in the highest concentration at 4.30 µg/L in the first irrigation while the 15G formulation was less than half at 1.8 µg/L. The irrigation water source is water diverted from the Stanislaus River into Littlejohns Creek where return flows prior to our outtake is possible. In the second irrigation, the inflow water contained a chlorpyrifos concentration of 0.008 µg/L, or about one-half the exceedance level. The second irrigation results are presented both as the raw value collected and the net value, which is the raw minus the irrigation water concentration. In the second irrigation, the net residue levels were much lower in comparison to the first irrigation at 0.457 µg/L (15G) and 0.0132 µg/L (4E). No detectable pyrethroid residues were found in the water or sediment samples.

Site 2

Concentrations of chlorpyrifos were found in excess of the water quality standard in the irrigation runoff from both irrigations and both formulations (Table 3-12). The 4E formulation resulted in the highest concentration at 0.360 µg/L in the first irrigation while the 15G formulation was less than at 0.250 µg/L. In the second irrigation, the levels were reduced in comparison to the first irrigation at 0.140 µg/L (15G) and 0.175 µg/L (4E). No detectable pyrethroid residues were found in the water or sediment samples.

Site 3

Concentrations of chlorpyrifos were found in excess of the water quality standard in the first irrigation runoff from both formulations (Table 3-12). The 4E formulation resulted in the highest concentration of 0.140 µg/L in the first irrigation while the 15G formulation was less than one third at 0.045 µg/L. In the second irrigation, only in the 4E formulation residues were in excess of the standard. The second irrigation residue levels were reduced in comparison to the first irrigation at 0.041 µg/L (15G) and 0.013 µg/L (4E). No detectable pyrethroid residues were found in the water or sediment samples.

Table 3-12 Irrigation and Runoff Water Chlorpyrifos Concentration at Each Irrigation and Site. Also shown is the Sum Concentrations of the Two Irrigations.

	Site 1			Site 2			Site 3		
	15G Runoff µg/L	4E Runoff µg/L	Irrigation Water µg/L	15G Runoff µg/L	4E Runoff µg/L	Irrigation Water µg/L	15G Runoff µg/L	4E Runoff µg/L	Irrigation Water µg/L
1st Irrigation	1.800	4.300	ND*	0.250	0.360	ND	0.045	0.140	ND
2nd Irrigation	0.465	0.140	0.008	0.175	0.140	ND	0.013	0.041	ND
2nd Irrigation Net**	0.457	0.132							
Sum Irr 1and 2	2.257	4.432		0.425	0.500		0.058	0.181	

*ND = Not Detected
**Net = Runoff minus irrigation water concentration

15G vs. 4E Formulation Residues

Residues measured in the runoff collected during the first irrigation at all sites indicate the use of the 15G formulation resulted in a reduced concentration of chlorpyrifos residues when compared to the 4E formulation. When evaluating the ratio of 4E to 15G residues, the range in the first irrigation was 1.4 to 3.4. Clearly, the 4E formulation resulted in substantially more residues in the runoff than the 15G. The results were similar in the second irrigation at Site 3 with a ratio of 3.1. However, at Sites 1 and 2, the 4E resulted in fewer residues than the 15G (Table 3-12). The different results between sites can be related to the higher soil bed porosity in Site 1, by virtue of the dry beds, and Site 2 being a more coarse soil (both factors addressed later). Additionally, the amounts of residues discharged in the 4E were much higher in Sites 1 and 2 than Site 3 in first irrigation, leaving less material available for discharge in the second irrigation.

First Irrigation vs. Second Irrigation Residues

A reduction in residue concentration from the first to the second irrigation occurred with both formulations and each site. For the purpose of comparison, the number of time the exceedance level of 0.015 µg/L was exceeded is presented for each individual analysis in Table 3-13. Site 1 had the largest reductions of about 4 times using the 15G while the 4E experienced a near 33 times reduction. It should be noted that the 4E formulation had the highest runoff residue concentration in the initial irrigation and the lowest concentration in the second irrigation. Site 2 experienced a 1.4 times reduction for the 15G while the reduction was greater at 2.6 times with the 4E, which was similar to Site 1. The Site 3 results were different in that the reductions from the first to second irrigation were nearly the same at about 3.5 times reduction from the initial irrigation. Site 3 had the least residues in the runoff during the first irrigation in comparison to the other sites which may have contributed to this result. It should also be noted that the concentration of the 15G at 0.013 µg/L is below the exceedance level.

Table 3-13 Irrigation and Runoff Water Chlorpyrifos Residues in Relation to the Water Quality Standard (0.015 µG/L) at Each Irrigation and Site, (x /standard). Also, Reduction of Chlorpyrifos Concentration as A Ratio of the First Irrigation to the Second.

	Site 1			Site 2			Site 3		
	15G	4E	Irrigation	15G	4E	Irrigation	15G	4E	Irrigation
	Runoff		Water	Runoff		Water	Runoff		Water
	Times Exceedance Level			Times Exceedance Level			Times Exceedance Level		
1st Irrigation	120	287	ND*	17	24	ND	3.0	9.3	ND
2nd Irrigation	31	9	0.52	12	9	ND	0.9	3.7	ND
2nd Irrigation Net**	30	9							
Ratio Irr 1 to 2***	3.9	32.5		1.4	2.6		3.5	3.4	

*ND = Not Detected
**Net = Runoff minus irrigation water concentration
*** Ratio of irrigation 1 to 2 or reduction ratio

Dry bed vs. Pre-irrigated Bed Residues

Higher concentrations of residues were found in runoff from the dry bed site 1 than the pre-irrigated bed Sites 2 and 3 in both formulations in the first irrigation (Table 3-12). In the second irrigation, this was true for only the 15G formulation. The 4E formulation was similar to Site 2 which was the coarser textured soil while being higher than Site 3 which was the medium textured soil (see the soil texture discussion below).

The 60-inch beds were formed in the spring from disked clayey ground to form a porous soil media. Irrigation water is introduced to the furrows via an open ditch through siphons. Since the water advance is not uniform in each furrow, the water gradient moves from the side of the bed receiving water and the dry side. This water gradient moves soluble residues to the opposite bed edge which is moved down the furrow. This may in part explain why the dry bed site (1) runoff concentrations were higher than both pre-irrigated sites (2 and 3). In the pre-irrigated beds, the soil was compacted by soil slaking upon wetting reducing the ability of the irrigation water to penetrate the bed. Also, less variability between furrow irrigation advance rates were noticed in the pre-irrigated beds. Lastly, the time from insecticide application to the irrigation (30 -31 days) with the soil at moisture content favorable for decomposition may also be a factor.

By summing the residue concentration of both irrigations within site (Table 3-12), the dry bed Site 1 resulted in 5 to 39 times the residues in the runoff when compared to pre-irrigated beds (Sites 2 and 3). This comparison assumes the runoff was equal in all sites, irrigations and formulations.

Pre-irrigated Bed Soil Texture Residue Differences

Sites 2 and 3 were both pre-irrigated bed sites. Site 2 was a more course-textured soil, a sandy loam, versus Site 3 being a sandy clay loam containing about two and a half times the clay content. Using the residue summing method for both irrigations described above, the more clayey soil (Site 3) resulted in 5 times less residues than the sandier soil at Site 2 when viewed across both formulations. Soils with a more coarse texture allow higher water flux into and out of the beds.

Chlorpyrifos vs. Permethrin

No detectable permethrin concentrations were found in water column or sediment samples which were collected at each site and irrigation.

Conclusions

Residues of chlorpyrifos were found in cornfield furrow-irrigation runoff where a granular and emulsified concentrate formulation was applied at seed planting. Runoff was measured in two post planting irrigations.

In all but the second irrigation using the 15G formulation at Site 3, runoff was found in exceedance of the water quality standard of 0.015 µg/L.

The practice of planting and applying insecticide to dry beds, then irrigating was found to produce the most residues vs. pre-irrigation followed by planting.

In all cases the chlorpyrifos concentration in the runoff water decreased from the first to the second irrigation (Table 3-12 and Figure 3-5).

Soil with greater clay content and using the pre-irrigation method resulted in reduced residues in the runoff waters (Figure 3-5).

The 15G formulation resulted in reduced residues when compared to the 4E formulation in the first irrigation at all sites. For the second irrigation, results were mixed. When summing the concentrations of both irrigations using the 15G formulation resulted in fewer residues than the 4E formulation at all sites.

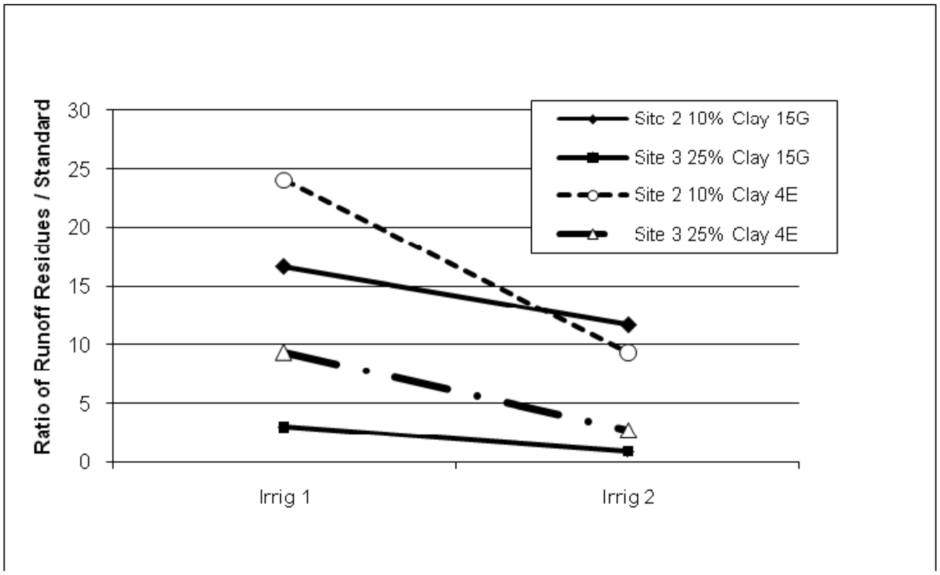

Figure 3-5 Runoff Residues by Formulation, Site and Irrigation

The use permethrin as an alternative to chlorpyrifos proved no only successful in terms of reducing runoff residues but resulted I equal pest control efficacy and reduced costs.

Management Practice Costs

Application costs were equal for all treatments, since fertilizer was injected into the seed row at all sites the 4E was added to the fertilizer and the application boxes were already mounted on the seeder. The cost of permethrin was significantly lower than the chlorpyrifos 15G similar to the chlorpyrifos 4E formulation (Table 3-14). All three treatments appeared to have the same efficacy.

Table 3-14. Treatment application rate and costs.

Treatment Material	Rate lbs a.i. per acre	Material Cost $ / acre
Chlorpyrifos 4E	1.3	11.99
Chlorpyrifos 15G	1.3	17.75
Permethrin 1.5G	0.13	12.26

<u>Codling Moth Pheromone Mating Disruption Evaluation in Walnut Summer 2009</u>

This evaluation compares pheromone-mating disruption to grower standard practice, which is to use both organophosphate and pyrethroid insecticides. Six growers representing nearly 200 acres committed to participation in the area-wide comparison program. The pheromone block is made up of 2 growers in a 110-acre contiguous block. The control (grower treatment) blocks (a combined 80 acres) is not contiguous but within ½ mile of the pheromone block.

The pheromone treatment was made at two rates of pheromone. P1 or low dose rate consists of 5 controlled discharge dispensers per tree at four trees per acre (20 ropes per acre). The P2 or high dose rate consists of 10 per tree at 4 trees per acre (40 ropes per acre). The pheromone used was Isomate-CTT. The rope dispensers were hung in trees April 25th. The applications in the grower standards were all the same – chlorpyrifos at two quarts per acre at 200 gallons volume per acre for the first spray and bifenthrin (Brigade) at 1.5 pound per acre for the second application.

Results:

Canopy counts of 100 nuts on ten replicates were made using pruning towers in all blocks 6/4/09. Canopy counts found < 1 % damage in any block with no significant differences between pheromone and grower standard blocks or the pheromone rates.

Canopy counts 100 nuts on ten replicates were again made 8/5/09 in all blocks. Damage again was low in all treatments and blocks at < 1 % with no significant differences between pheromone and grower standard blocks or the pheromone rates.

Harvest nut samples were collected from the previously measured trees in each block on 9/25/09 through 11/5/09. Nuts were hulled, cracked and evaluated for the presence of codling moth larvae. No significant differences in the presences of larvae were found between the pheromone treated blocks and the conventionally treated (OP/pyrethroid pesticides) blocks. The average pheromone treated block nut damage due to larvae was 0.8% while the average of the OP treated blocks was 0.5% damaged nuts. No significant differences were found between the low pheromone rate (P1) and the high rate (P2).

Management Practice Costs

Since no significant differences existed between treatments, no economic advantage or disadvantage was found in the nut grade data. However, cost of material plus applications were different between treatments. The conventional treatments of Lorsban and Brigade and two applications totaled $77.30 per acre. The low pheromone rate totaled $73.50 per acre for material and hanging while the high pheromone rate was $133.50. These results indicate the low rate was adequate to control the light codling moth population found in the 2009 season when compared to the higher rate of pheromone and the OP/Pyrethroid treatment. It should be restated that 2009 was a light codling moth population season and that the program was conducted on relatively large contagious acreage. Pheromones look to be an economical substitute for OP and pyrethroid insecticides used for codling moth when a large area is committed to the program—150 to 600 acres of continuous coverage.

<u>Application Options for Applying Landguard OP-A in Surface Irrigated Alfalfa Summer 2009</u>

The goal was to determine the potential of using Landguard OP-A to treat runoff water by applying the enzyme in the irrigation inflow water. The evaluation was conducted in the Littlejohns subwatershed. OP-A is an enzyme based product recently available for rapidly hydrolyzing certain OP pesticides such as chlorpyrifos and diazinon—both commonly found in exceedances in the target area. Comparisons were made as to the quantity of material required and practicality for treatment of inflow and runoff water. To minimize the product used and still treat the entire volume of runoff water, irrigation water was allowed to travel down slope in the field until it reached 60% of the field length. At that time a visual tracer composed of lime sulfur was injected into the irrigation water. The advance of the irrigation water plus tracer was monitored as it moved down slope. During this period the irrigation water without tracer, which was applied earlier, continued to advance down the field until it was completely infiltrated (Figure 3-6). At this point the irrigation water containing the tracer became the advancing front and remained so to the end of the field and during runoff. The tracer was injected until the inflow water was stopped and therefore all the water as runoff would have been treated.

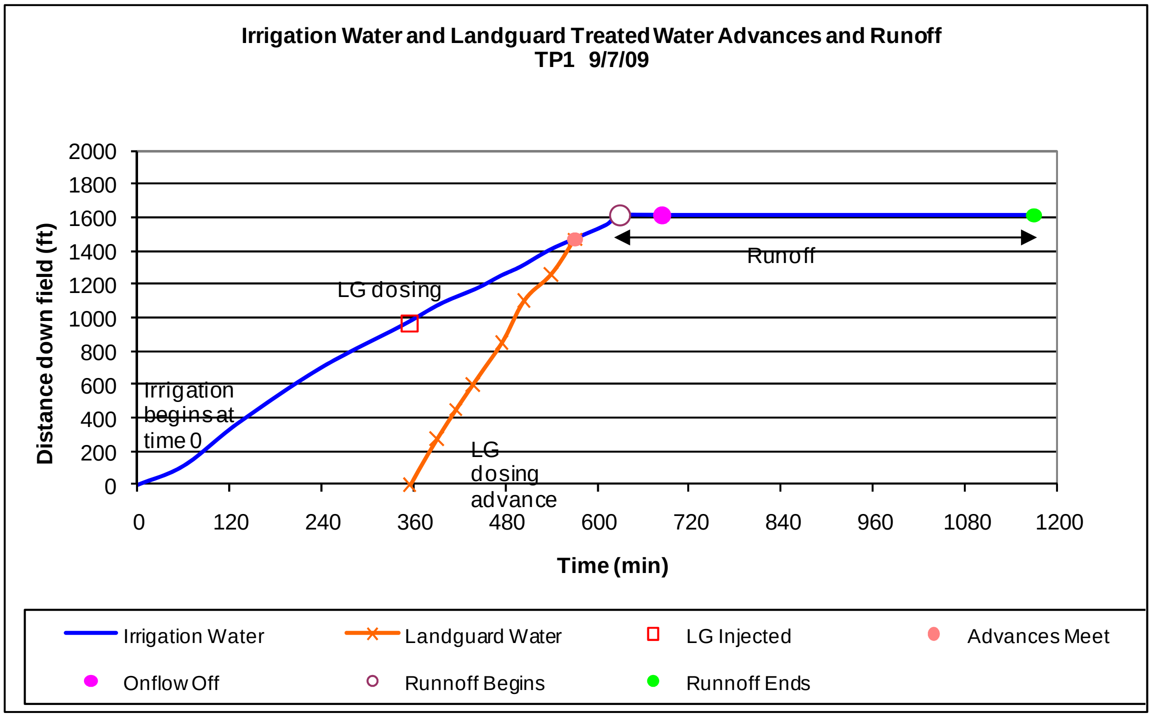

Figure 3-6 Irrigation Water Advance and Landguard Injection Points

Results

Other evaluations of Landguard OP-A in treating runoff waters at 0.00005 g/L were found to be complete (concentration of chlorpyrifos being below 0.015µg/L) within a short period of time. When treating inflow water a sixty minute lag time was noticed before treatment was complete as determined by runoff sample concentration of chlorpyrifos being below 0.015µg/L (Figure 3-7). The goal was to have no discharge of chlorpyrifos in runoff waters above the water quality standard of 0.015µg/L. Nine percent of the runoff water exceeded the 0.015ppb water quality standard for chlorpyrifos in the first 60 minutes of runoff. After the 60 minute measurement all samples of runoff collected for the entire 660 minute runoff period were below the water quality standard. The higher Landguard application rate was similar in results to that of the 0.00005 g/L rate. The cause of the time lag before complete treatment is unknown. A higher dose rate for a shorter period of time (injected later in the irrigation advance time) which would still be overtake the advance of untreated water before runoff begins may have merit.

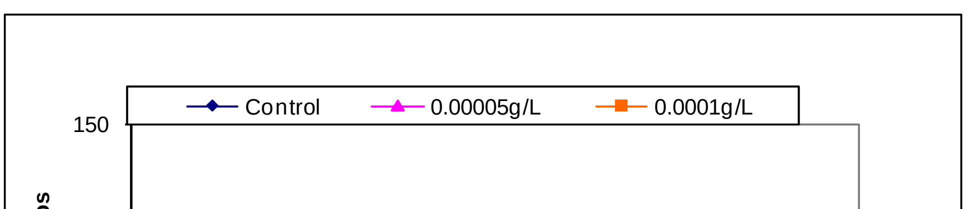

Figure 3-7 Percent Reduction of Chlorpyrifos Concentration in Runoff Waters from the Beginning of Runoff for 60 Minutes by Treatment

The runoff rate was measured to determine the amount of OP-A which would be required in a runoff ditch treatment. The runoff hydrograph is shown in Figure 3-8. Two options exist in runoff treatment using OP-A. First is to set a single rate dosing device to apply the desired concentration at the maximum flow rate. This method allows for all with runoff water to have a minimum dosing rate to ensure all the runoff waters are treated with the desired rate. Another option is to measure the runoff water flow rate and vary the application of OP-A to dose so that all runoff waters receive the desired dose. The second option uses less material by about 1/3 more material was required when treating the inflow water as the single dosing (a single dosing rate at the maximum flow for the entire runoff period) (Table 3-15). The advantage to inflow water treatment is that the mechanics of injecting at a single rate to a constant volume. The timing of the injection during the irrigation suits the current irrigation style in contrast to not knowing when the runoff will begin. Additionally, it has been reported that chlorpyrifos can be contained in runoff waters after more than the initial irrigation after application. Using the inflow-irrigation injection option raised the possibility the OP-A will hydrolyze the OP pesticide residue remaining on plant tissues and the soil surface. The need for a runoff water dosing unit that can meet the variable runoff volume would dramatically reduce the amount of material required. Currently irritation water inflow treatment remains as a possibility for runoff treatment however more work is need to fine tune dosing times and concentrations to ensure adequate treatment in the first 60 minutes of the 660 minute runoff period.

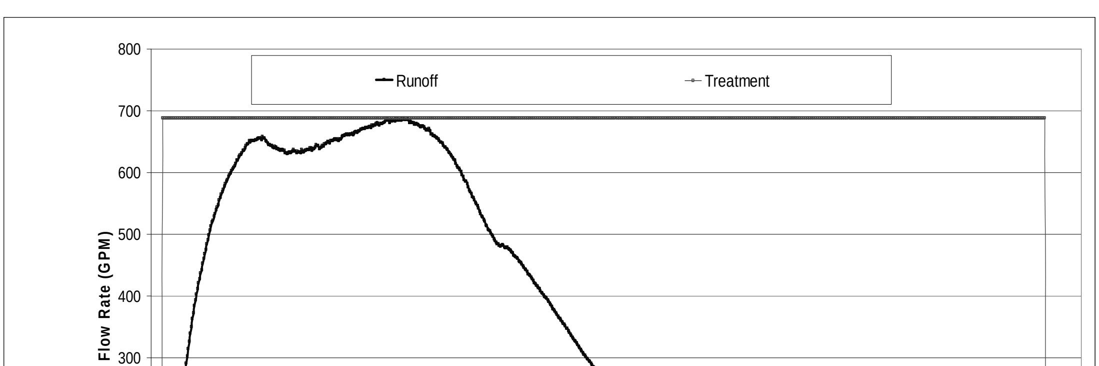

Figure 3-8 Runoff Hydrograph

The amount of material required to treat irrigation inflow waters and runoff waters with two rates of OP-A along with estimated costs of material are shown in Table 3-15.

Table 3-15. Landguard OP-A Use with Different Treatment Options

Treatment Method			0.00005	0.0001		0.00005
			Grams per Check			Cost
Treating inflow			41.7	83.3		$/Acre
Treating runoff at max flow			27.60	55.20		
Treating runoff using variable rate			14.90	29.80		
			Grams per Acre			
Treating inflow			20.9	41.7		41.70
Treating runoff at max flow			13.8	27.6		27.60
Treating runoff using variable rate			7.4	14.9		14.90

Management Practice Costs

The cost of the Landguard OP-A material is currently difficult to determine due its limited availability from CSIRO, the Australian governmental entity which controls the product. Plans are underway to transfer production and distribution in the US to a private company. Currently a Landguard OP-A is available for $2.00 for per gram. Table 3-15 indicates the price per acre of treatment in the inflow water and in the measured runoff in this alfalfa field treating at a fixed rate and using variable rate technology.

<u>The Use of Polyacrylamide (PAM) to Reduce Sediment Loss in Tomato-Summer 2009</u>

PAM is effective in controlling pesticide residues (primarily pyrethroids) which are attached to soil particles that leave the field, or are generated in the tail water ditch through erosion during irrigation. Studies have shown that this erosion occurs along the field length for furrow irrigation. PAM is a solid or liquid water-soluble polymer that flocculates sediments –

binding them together and causing them to drop out of the water. When added to runoff waters, PAM can mitigate transport of sediment-adsorbed pesticides from furrow-irrigated fields. Liquid PAM can be constantly injected into the irrigation water, constantly deposited in granular form into turbulent irrigation ditch water, or applied to the furrow as dry tablets (40 % PAM) or granules (89 % PAM), where it is slowly dissolved by irrigation water. The in-furrow methods are generally less expensive and easier to apply than liquid or granular PAM applied to the inflow ditch or piped water. However, they do not allow for equally precise control of product concentration. There has been no known use of PAM in the target area although runoff containing sediments is common in furrow-irrigated crops.

A tomato field with two rows planted to a 60 inch bed was selected to evaluate both the "patch" placement of granular PAM and the tablet formulation. The field length was 600 feet and the field had been cultivated since the previous irrigation. The granular product (one ounce per furrow) was placed as a one-foot patch in the furrow at 100 feet from the start of the furrow. A 50-gram tablet was placed at the same 100-foot distance as well as a second tablet at a 600-foot distance. Granular PAM is 89% active material while the tablets are 40% active material. The soil was a clay loam and water was supplied from Littlejohns Creek.

Results

Total suspended sediment concentration in the runoff was measured for the entire 200-minute runoff period. Suspended sediment concentration was reduced by an average of 83% over the untreated control. Sediment reduction was similar between the granular and the tablet treatments. The greatest sediment reduction occurred in the first half of the runoff period. Measurements of suspended sediments made during the subsequent irrigation showed significant reductions by the PAM treatments compared to the untreated control; however, the total sediment discharge was much lower than for the first irrigation after the field had been cultivated.

Costs

Both treatments were equally effective but the costs were significantly different, with cost of material and application labor being highest for tablets (Table 3-16). It is recommended that a single tablet be evaluated for effectiveness in a specific field, which, if effective, would reduce the costs of the material. Two tablets would probably be necessary on furrow lengths over 600 feet. Costs are dependent on row spacing and furrow length. In this evaluation, if furrow length was doubled to 1200 feet the cost would be reduced by one-half, with efficacy probably similar to that of the 600-foot furrows (using 2 tablets). Likewise, a field with 30-inch beds would result in an increased cost.

Table 3-16 Cost of PAM Material and Application Labor for a 600-Foot Furrow Length

Treatment	Rate	Material Cost	Application Cost	Total Cost
	Amount per furrow	$ per treated acre	$ per treated acre	$ per treated acre
Granular "patch"	1 oz per furrow	2.48	0.10	2.58
Tablets	2 tablets per furrow	12.76	0.14	12.90

Task 4 Water Quality Monitoring

Subtask 4.1 Analysis of baseline water quality date for Coalition area. Deliverable: report on baseline water quality date per monitoring site/subwatershed, including number of exceedances reports filed per site. Projected date for completion: 01/01/2009. **Subtask 4.2** Perform water quality/toxicity monitoring according to the ILRP quality assurance project plan and Monitoring and Reporting Plans Deliverables: Copies of exceedance reports submitted to regional Water Quality Control Board. Written analysis of monitoring results. Projected date for completion: submitted with each quarterly report through the term of the agreement through 02/01/2011 **Subtask 4.3** Compare baseline data to the latest sampling data. Project deliverables: a side by side comparison of baseline and new data for each site where chemicals of concern cause toxicity. Written analysis of comparisons between baseline data, the current year's data, and the previous year's data (after the first year of sampling under this grant program). Projected date for completion: 04/01/2011

- *Subtask 4.1 Analysis of Baseline Water Quality Data*

The target area for this project includes the contiguous subwatersheds of Duck Creek, Littlejohns Creek, Temple Creek and Lone Tree Creek each terminating at Jack Tone Rd with the exception of Duck Creek which terminates at Hwy 4. The 2008 year is the best time period to use as a baseline in the targeted area. This is due to a change in the Irrigated Lands Program sampling schedule requiring more samples to be collected going forward from 2007. The same sample schedule was followed in 2009 and 2010 for water column and sediment samples in the target area.

Table 4-1 lists the 2008 water column water quality exceedances of chlorpyrifos, diazinon, and malathion in the target area. For a complete listing of sampling dates and concentration of exceedances see Table 4-2. During the baseline year (2008) there were 14 chlorpyrifos exceedances in the target area averaging 1.95 µg/L (Table 4-1). Malathion and diazinon standards were exceeded a single time each at concentration of 0.22 and 0.2 µg/L respectively. The sediment toxicity using Hyalella *azteca* was determined when less than 80% Hyalella survival was found in the sediment sample. As per the 2008 ILRP Monitoring Plan additional chemical analysis was not conducted to determine the cause of the toxicity. It is suspected that sediment-adsorbed pesticides like pyrethroids or chlorpyrifos were responsible for the toxicity.

In 2010, the Monitoring Plan was changed to include chemical analysis of pyrethroids and chlorpyrifos. In 2010 sediment toxicities, across all the coalition's sampling, was found to always contain pyrethroids and to a lesser number of samples chlorpyrifos. Based on the 2010 results it is reasonable to assume, for comparison, the sediment toxicities occurring in 2008 are probably the result of pyrethroids or chlorpyrifos. Sediment toxicities occurred three times during the baseline year with an average toxicity of 52% Hyalella survival.

Table 4-1 Chlorpyrifos, Diazinon, and Malathion Water Quality Exceedances (Water Column) in The Target Area and the Average Concentration of Constituents. Sediment Sample Toxicity and Average Survival Percentage of Hyalella in 2008

		Total Targeted Area 2008
Water Column Exceedances		
chlorpyrifos	Number of Exceedances	14
	Average exceedance Concentration µg/L	1.95
diazinon	Number of Exceedances	1
	Average exceedance Concentration µg/L	0.2
malathion	Number of Exceedances	1
	Average exceedance Concentration µg/L	0.22
Sediment Hyalella Toxicity*		
Hyalella Toxicity	Number of Toxicities	3**
	Average Percent Survival	52

*Hyalella Toxicity if survival below 80%.

** 2008 presumed to be pyrethroid or chlorpyrifos toxicity

- *Subtask 4.2 Perform Water Quality/Toxicity Monitoring According to the ILRP Quality Assurance Project Plan and Monitoring and Reporting Plans*

All subwatersheds were monitored according to the ILRP quality assurance project plan and Monitoring and reporting Plans. Copies of the exceedance reports were submitted in the semi-annual reports. Table 4-2 contains the entire list of water column exceedances and sediment toxicities by subwatershed, sample date and constituent for 2008-2010.

Table 4-2. Water Quality Exceedances and Sediment Toxicities by

Subwatershed, Sample Date, and Constituent (2008-2010)

Station Name	Season	Sample Date	Chlorpyrifos, µg/L	Diazinon, µg/L	Malathion, µg/L	*Hyalella azteca, Survival (%)*
Duck Creek @ Hwy 4	Irrigation1	4/15/2008	0.057			
Duck Creek @ Hwy 4	Irrigation3	6/10/2008	0.110		0.22	
Duck Creek @ Hwy 4	Irrigation4	7/15/2008	0.066			
Duck Creek @ Hwy 4	Irrigation5	8/12/2008	0.017			
Duck Creek @ Hwy 4	Irrigation6	9/16/2008	0.027			
Duck Creek @ Hwy 4	Irrigation3	6/9/2009	0.070			
Duck Creek @ Hwy 4	Irrigation4	7/14/2009	0.150			
Duck Creek @ Hwy 4	Irrigation5	8/11/2009	0.031			
Duck Creek @ Hwy 4	Irrigation2	5/11/2010	0.055			
Duck Creek @ Hwy 4	Irrigation4	7/13/2010	0.020			
Duck Creek @ Hwy 4	Irrigation5	8/10/2010	0.3			
Duck Creek @ Hwy 4	Sediment	9/14/2010				17*
Littlejohns Creek @ Jack Tone Rd	Irrigation1	4/15/2008	0.034			
Littlejohns Creek @ Jack Tone Rd	Irrigation3	6/10/2008	0.077			
Littlejohns Creek @ Jack Tone Rd	Irrigation4	7/15/2008	0.025			
Littlejohns Creek @ Jack Tone Rd	Fall 2	11/9/2010	0.04			
Temple Creek @ Jack Tone Rd	Storm1	1/23/2008	0.045			
Temple Creek @ Jack Tone Rd	Storm Sed	3/18/2008				54**
Temple Creek @ Jack Tone Rd	Storm Sed	4/9/2008				21**
Temple Creek @ Jack Tone Rd	Irrigation2	5/13/2008	0.410			
Temple Creek @ Jack Tone Rd	Irrigation3	6/10/2008	0.120			
Temple Creek @ Jack Tone Rd	Irrigation4	7/15/2008	0.028			
Temple Creek @ Jack Tone Rd	Irrigation5 Sed	8/13/2008				82**
Temple Creek @ Jack Tone Rd	Irrigation6	9/16/2008	0.120			
Temple Creek @ Jack Tone Rd	Irrigation2	5/12/2009	0.032			
Temple Creek @ Jack Tone Rd	Irrigation4	7/14/2009	0.660			
Temple Creek @ Jack Tone Rd	Irrigation6	9/15/2009	0.086			
Temple Creek @ Jack Tone Rd	Irrigation 5	8/10/2010	0.039			
Temple Creek @ Jack Tone Rd	Sediment	9/7/2010				76***
Temple Creek @ Jack Tone Rd	Fall2	11/9/2010	0.052			
Temple Creek @ Jack Tone Rd	Fall3	12/7/2010	0.068			
Lone Tree Creek @ Jack Tone Rd	Storm1	1/23/2008	1.700	0.2		
Lone Tree Creek @ Jack Tone Rd	Irrigation5	8/11/2009	0.100			
Lone Tree Creek @ Jack Tone Rd	Storm1	1/13/2010	1.100			
Lone Tree Creek @ Jack Tone Rd	Irrigation4	7/13/2010	0.270			

*Sample retested due to highly variable replicate test; retest not toxic
**Toxicity < 80% Survival. 2008 samples not further analyzed for constituents as per Monitoring Plan
***Chlorpyrifos and pyrethroid detected

- *Subtask 4.3 Compare Baseline Data to the Latest Water Quality Data for the Target Area*

A comparison of baseline year (2008) and the latest year's (2010) exceedance count and sediment toxicity as well as the average concentration of each exceedance are shown in Table 4-3. As a sum thee subwatersheds, the same information for entire target area is also shown.

Table 4-3 Yearly Water Column Exceedances and Sediment Toxicities, with Average Concentration or Survival, in Each Subwatershed for \Constituents of Concern for 2008-2010.

		Duck Creek		Littlejohns Creek		Temple Creek		Lone Tree Creek		Entire Target Area	
		2008	2010	2008	2010	2008	2010	2008	2010	2008	2010
Water Column Exceedances											
chlorpyrifos	Number of Exceedances	5	3	3	1	5	3	1	2	14	9
	Average exceedance Concentration µg/L	0.06	0.13	0.05	0.04	0.14	0.05	1.70	0.69	1.95	0.90
diazinon	Number of Exceedances							1		1	
	Average exceedance Concentration µg/L							0.2		0.2	
malathion	Number of Exceedances	1								1	
	Concentration µg/L	0.2								0.22	
Sediment Hyalella Toxicity*											
	Number of toxicities					3**	1***			3**	1***
	Average Percent Survival					52	76			52	76

*Hyalella Toxicity if survival below 80%.
** 2008 presumed to be pyrethroid or chlorpyrifos toxicity
***2010 Confirmed by chemical analysis to have both pyrethroids and chlorpyrifos present

Substantial reductions in water quality exceedance counts and average concentrations (or survival for sediment samples) were achieved in the target area when the latest data (2010) is compared to the 2008 baseline (Table 4-4). The reduction in exceedance count of chlorpyrifos was 36% while the average concentration decreased 54% from 2008 to 2010. Diazinon and malathion had only a single exceedance in 2008 with no exceedances in 2010. In 2010 the sediment samples in which had less than 80% survival were analyzed for pyrethroids and chlorpyrifos. The single toxic sample contained both pyrethroids and chlorpyrifos. Assuming similar results for the 2008 samples, Hyalella assessed sediment toxicity was reduced by 67 percent from the 2008 to the 2010 samplings.

Table 4-4 Yearly Exceedances and Average Concentration (or survival) for the Total Target Area, in 2008 and 2010, for the Constituents of Concern. Also Shown Are the Percentage Reduction in Exceedance Count and Average Concentration

		Total Targeted Area		% Reduction
		2008	2010	2008-2010
Water Column Exceedances				
chlorpyrifos	Number of Exceedances	14	9	36
	Average exceedance Concentration µg/L	1.95	0.90	54
diazinon	Number of Exceedances	1		100
	Average exceedance Concentration µg/L	0.2		
malathion	Number of Exceedances	1		100
	Concentration µg/L	0.22		
Sediment Hyalella Toxicity*				
Toxicity	Number of Toxicities	3**	1***	67
	Average Percent Survival	52	76	25

*Hyalella Toxicity if survival below 80%.

** 2008 presumed to be pyrethroid or chlorpyrifos toxicity

***2010 Confirmed by chemical analysis to have both pyrethroids and chlorpyrifos present

The data do not permit meaningful statistical analysis. It is possible, however, to observe a numerical decrease in the numbers of exceedances of water quality standards during the term of the project. The number of water quality exceedances for chlorpyrifos decreased in all subwatersheds with the exception of Lone Tree Creek which increased from one to two exceedances, comparing the baseline year (2008) to 2010 (end of project) (Figure 4-1). When comparing the total target area for 2010 to the baseline year (2008) the count water column of exceedances decreased by 36% in 2010. Sediment toxicity counts decreased over the same time comparison by 67%.

Project Analysis

The primary goal of the project was to reduce water quality exceedances of constituents of concern in the target area. Measurements of success were:

1) Reduced exceedances of the constituents of concern from the baseline year (2008) and 2010 in both the water column and sediment samples collected through the Coalition’s monitoring program.
2) Documented implementation of management practices known to be effective in reducing offsite movement of pesticides.
3) Reduced use of constituents of concern in the target area from the baseline year.

This goal was facilitated by production and use of a risk analysis workbook, grower workshops, and a substantial grower outreach program. Workbook materials in draft form were used in outreach efforts in 2009 prior to the full publication becoming available.

<u>Reduced Exceedances in Target Area from Baseline Year</u>

Chlorpyrifos Exceedances in the Water Column

All four target subwatersheds comprise the total target area forms the Coalition Zone 2 (Figure 5-1). While this past year (2010) Zone 2 has seen a slight increase in chlorpyrifos exceedances from 2009 (Figure 5-2), the average of the 2009 and 2010 exceedances when compared to the baseline year were reduced by about 30%.

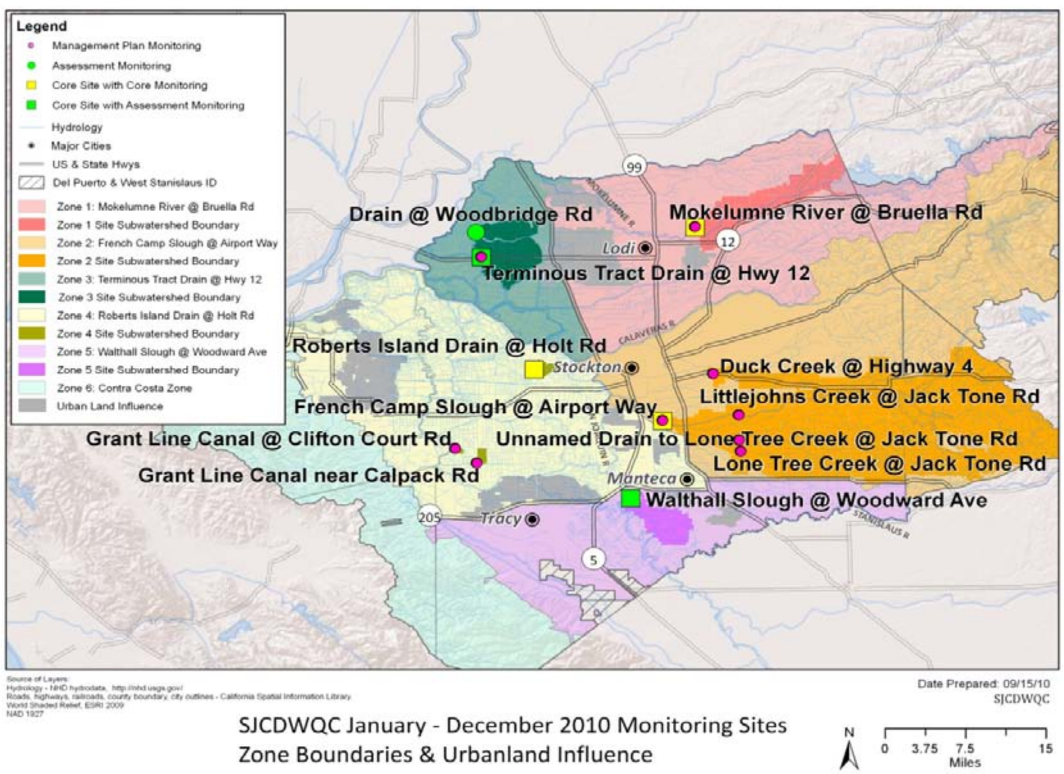

Figure 5-1 SJCDWQC January through December 2010 Monitoring Sites Relative to Zone Boundaries.

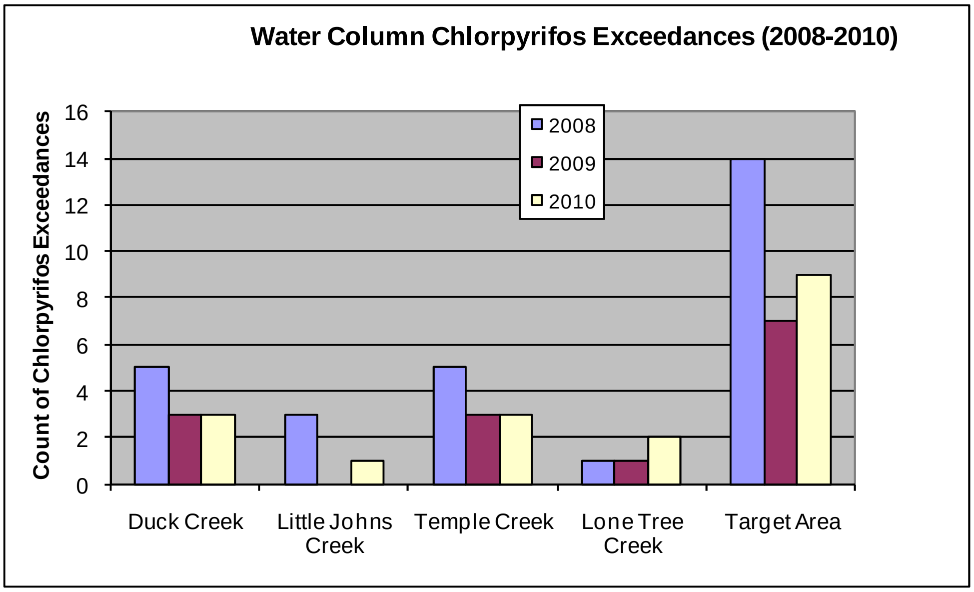

Figure 5-2 Water Column Exceedance Counts of Chlorpyrifos Water Quality Trigger Limit From 2008 – 2010 Within the Target Area.

Six of the nine exceedances experienced in 2010 were from the Duck Creek and Temple Creek sampling location. This was the same number as experienced in 2009 with both being reduced from the five exceedances each in 2008. Littlejohns Creek exceedances were at five in the baseline year dropping to zero in 2009 then at one for 2010. In 2008 and 2009, Lone Tree Creek had a single exceedance each year; in 2010, two exceedances were experienced.

When comparing the exceedance count for chlorpyrifos in 2008 baseline year with 2009 and 2010 the total target area experienced a 50% reduction in 2009 and a 36% reduction in 2010 Table 5-1).

Table 5-1 Percentage Reduction in Chlorpyrifos Exceedances in the Water Column from the Baseline Year 2008

	% reduction from 2008	
Area	2009	2010
Duck Creek	40	40
Little Johns Creek	100	67
Temple Creek	40	40
Lone Tree Creek	0	-100
Total Target Area	50	36

Diazinon and Malathion Exceedances in the Water Column

No exceedances of water quality standards occurred in 2009 or 2010 in diazinon or Malathion in the target area. There were two sediment sample Hyalella toxicities both found to be related to chlorpyrifos.

Sediment Toxicity

Sediment toxicity to *Hyalella azteca* occurred once in 2010 within a single subwatershed and was found to be linked to both chlorpyrifos and pyrethroids. This is a 50% reduction from the baseline year of 2008.

Management Practice Implementation

Throughout 2010 management practice monitoring continued in the target area Results from management practice follow up surveys have come in for these subwatersheds and are complete.

In the Duck Creek and Lone Tree Creek subwatershed nearly 50% of the targeted acres implemented new management practices in 2009 while Temple Creek was at 61%. Littlejohns Creek was at 91% in 2010 (Table 5-2).

Table 5-2 Percentage of the Target Grower Contacts with New Management Practices. Results Based on Irrigated Acres.

Subwatershed	Acreage of Targeted Members	Targeted Acres with New Practices	Percent of Contacts with New Practices	Years Implemented
Duck Creek @ Hwy 4	4,978	2,425	49%	2009-2010
Lone Tree Creek @ Jack Tone Rd	3,742	1,923	51%	2009-2010
Temple Creek @ Jack Tone Rd	6,463	3,934	61%	2009-2010
Littlejohns Creek @ Jack Tone Rd	2,796	2,566	92%	2010

Reduced Use of Constituents of Concern

Constitutes of concern are based on the number of exceedances that occur in the target area in the baseline year. The constituents with the highest water column exceedance count from 2004 to 2010 are chlorpyrifos and diazinon.

Chlorpyrifos

The number of applications and amount (pounds) of active ingredient applied to the total target area has declined drastically in 2010 (Table 5-3). In 2008 240 applications were made comprising 29,428 pounds of the active ingredient chlorpyrifos. In 2010 it was reduced to 93 applications (61% reduction from the 2008 level) and 9,471 pounds of active ingredient (68% reduction from the 2008 level). Not all subwatersheds experienced reductions. Littlejohns and Temple Creek increased somewhat but the reductions in Duck Creek and Lone Tree Creek were substantial.

Table 5-3 Number of Chlorpyrifos Applications and Pounds Active Ingredient Applied In Each Subwatershed and the Total Target Area

	2008		2010	
Chlorpyrifos	Number of Applications	Pounds a.i Applied	Number of Applications	Pounds a.i Applied
Duck Creek	26	1,240	13	835
Little Johns Creek	22	1,173	12	2,674
Temple Creek	26	1,904	9	2,796
Lone Tree Creek	166	25,111	59	3,166
Total Target Area	240	29,428	93	9,471
Percent reduction from 2008			61	68

<u>Diazinon</u>

The number of applications and amount (pounds) of active ingredient applied to the total target area has declined drastically in 2010 (Table 5-4). In 2008 24 applications were made comprising 1,291 pounds of the active ingredient diazinon. In 2010 it was reduced to 8 applications (67% reduction from the 2008 level) and 156 pounds of active ingredient (88% reduction from the 2008 level). Not all subwatersheds experienced reductions. Littlejohns and Temple Creek increased somewhat but the reductions in Duck Creek and Lone Tree creek was substantial.

Table 5-4 Number of Diazinon Applications and Pounds Active Ingredient Applied in Each Subwatershed and the Total Target Area in 2008 and 2010

	2008		2010	
Diazinon	Number of Applications	Pounds a.i Applied	Number of Applications	Pounds a.i Applied
Duck Creek	7	558	4	40
Little Johns Creek	5	20	3	103
Temple Creek	0	0	0	0
Lone Tree Creek	12	713	1	13
Total Target Area	24	1,291	8	156
Percent reduction from 2008			67	88

Pyrethroids

The pyrethroids of concern include s-cypermethrin, bifenthrin, deltamethrin, fenpropathrin, lambda-cyhalothrin, esenvalerate, and beta/gamma cyhalothrin, all registered on one of the four tatget crops. The (pounds) of active ingredient applied to the total target area has declined drastically in 2010 (Table 5-5). In 2008 2999 pounds of the pyrethroid active ingredients were applied in contrast to 1157 pounds in 2010. The reduction represented a 61% reduction between the two years. It is difficult to look at the pesticide use data and indicate a definite reason any reductions based on pest pressure and changing crop types that may be grown in the target area.

Table 5-5 Pyrethroids Applied (Pounds of Active Ingredient) in Each Subwatershed within the Target Area and the Target Area as a Whole in 2008 and 2010

Pyrethroids	**2008 Pounds a.i. Applied**	**2010 Pounds a.i. Applied**
Duck Creek	**515**	**108**
Littlejohns Creek	**389**	**307**
Lone Tree Creek	**1392**	**363**
Temple Creek	**702**	**378**
Target Area	**2999**	**1157**
Percent reduction from 2008		**61**

Appendix A

Table A-1 Outreach meetings conducted to reinforce management practices

Date	Area	Details	Who	Attendees
1/16/08	Lodi Area	California Cherry Research Review & Growing Sweet Cherries Organically Workshop to promote managing storm runoff from orchards. Presented research results comparing runoff volumes in a cover crop and clean cultivated conditions. Discussed delayed dormant	Terry Prichard	102
2/28/08	Stockton Area	Tri-County Walnut Institute Meeting with landowners and PCAs to discuss strategies to minimize pesticide residues in runoff from walnut orchards, specifically in early season (late March- May).	Terry Prichard	86
3/10/08	Grant Line Canal	Grower meeting focusing on exceedances that occurred each spring as a result of chlorpyrifos applications for alfalfa weevil. Trial results from a Prop50 study conducted within the Grant Line Canal area were discussed including the efficacy of other products	John Meek, Terry Prichard	15
3/20/08	Stockton Area	Energy, Irrigation, and Regulation Workshop: Discussed ag diesel engine regulation, the current status of ILRP, and management practices to improve water use, improve runoff, and to control offsite movement of ag residues.	Mike Wackman, Terry Prichard	65
4/25/08	Linden Area	Making Pheromone Mating Disruption Work in Walnut outreach meeting	Terry Prichard	29
5/1/08	Delta Area	Grower outreach meeting discussing exceedances from the previous irrigation season and BMPs for the upcoming irrigation season.	MLJ-LLC, Mike Wackman, Terry Prichard	62
5/2/08	All subwatershed sites in Tracy Area	Grower outreach meeting discussing exceedances from the previous irrigation season and BMPs for the upcoming irrigation season.	MLJ-LLC, Mike Wackman, Terry Prichard	45
7/15/08	Lone Tree Creek Subwatershed	Alfalfa, corn, and tomato grower meeting to address recent exceedances in area and review BMPs.	Mike Wackman, Terry Prichard	18
7/16/08	Lone Tree Creek Subwatershed	Walnut and grape growers meeting to address recent exceedances in area and review BMPs.	Mike Wackman, Terry Prichard	37

Date	Area	Details	Who	Attendees
10/15/08	Central Delta Region	Individual grower meeting to tour grower's farm then discuss the importance of understanding current irrigation and pesticide application practices and implementing management practices in achieving water quality objectives specific to individual grower.	Mike Wackman, Terry Prichard, Rachelle Antinetti, Parry Klassen, UC Farm Advisor	6
11/18/08	Stockton Area	Agricultural Commissioner's meetings to update and review laws and regulations	Terry Prichard	68
11/20/08	Ripon, Manteca, Escalon Areas	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.(2 meetings)	Terry Prichard	285
11/21/08	Lone Tree Creek Area	Individual grower meetings to discuss chlorpyrifos exceedances linked with individual grower use. Meetings included a visit to growers' fields to view runoff conditions and suggest/discuss potential management practices.	Rachelle Antinetti, Terry Prichard, and Joe Gasper (PCA)	6
11/24/08	Duck Creek subwatershed	Grower meeting to address measured water quality standard exceedances and to discuss BMPs and pesticide product options.	Mike Wackman, Terry Prichard	37
11/24/08	Linden Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	Rachelle Antinetti	115
11/25/08	Escalon Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	MLJ-LLC, Mike Wackman	153
12/2/08	Stockton Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	MLJ-LLC, Mike Wackman	223
12/3/08	Delta	Asparagus Grower Association Annual Meeting	Mike Wackman	45
12/4/08	Tracy Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	MLJ-LLC, Mike Wackman	180
12/9/08	Lodi Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	Rachelle Antinetti	175
12/18/08	Stockton Area	Agricultural Commissioner's meetings to update and review pesticide laws and regulations.	Terry Prichard	146
3/5/09	Escalon	Grower Meeting hosted by Mid Valley Agricultural Services at Escalon Sportsman Club. Invited all Mid Valley Ag's PCAs to discuss the program and distribute surveys. Approximately 50 growers attended.	Terry Prichard, Mike Wackman	50
7/15/09	Stockton	Large grower meeting hosted in part by Spray Safe; meeting held in San Joaquin Agricultural Center.	Terry Prichard	310

Date	Area	Details	Who	Attendees
11/17/09	Simms	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	213
11/17/09	Lodi	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	173
11/17/09	Stockton	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	74
12/1/09	Stockton	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	139
12/8/09	Lodi	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	159
12/8/09	Lodi	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	37
12/10/09	Simms	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	82
12/10/09	Simms	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	172
12/10/09	Stockton	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	83
12/15/09	Tracy	Grower meetings hosted by local Agriculture Commissioners attended by Coalition representative.	Mike Wackman	120
1/25/10	Littlejohns Creek	Tree and vine grower outreach meeting discussing exceedances from the previous irrigation season and BMPs for the upcoming irrigation season.	Mike Wackman, Terry Prichard	21
1/28/10	Grantline and Little-johns	Row crop grower outreach meeting discussing exceedances from the previous irrigation season and BMPs for the upcoming irrigation season.	Mike Wackman, Terry Prichard, Mick Canevari	7
2/10/10	Stockton	Large grower meeting hosted in part by Spray Safe; meeting held in San Joaquin Agricultural Center.	Terry Prichard & Franz Niederholzer	335
3/25/10	Duck, Lone Tree, Littlejohns, and Temple Creek	Winegrape Grower Workshop: meeting to introduce and explain how to use the DPR Grant--Walnut Management Practice Workbook.	Terry Prichard, Mike Wackman, Paul Verdegaal, & Walt Bentley	16
5/10/10	Duck, Lone Tree, Littlejohns, and Temple Creek	Walnut Grower Workshop: meeting to introduce and explain how to use the DPR Grant--Walnut Management Practice Workbook. Of the 68 growers and associated PCAs invited.	Terry Prichard, Mike Wackman, Joe Grant	21

Date	Area	Details	Who	Attendees
7/6/10	Duck, Lone Tree, Littlejohns, and Temple Creek	Alfalfa Grower Workshop: meeting to introduce and explain how to use the DPR Grant--Alfalfa Management Practice Workbook. 26 growers and associated PCAs invited.	Terry Prichard and Mick Canevari	14
9/29/10	Duck, Lone Tree, Littlejohns, and Temple Creek	Tomato Grower Workshop: meeting to introduce and explain how to use the DPR Grant--Alfalfa Management Practice Workbook. 12 growers and associated PCAs were invited.	Terry Prichard and Brenna Aegerter	8
11/9/10	Westley	A Role for PCAs/CCAs in Water Quality Protection Meeting. Discussed new ILRP requirements, a PCA's role in water quality issues, and the relationship between CCA programs and water quality issues. Also discussed were pesticide fate and pathways to surface	Terry Prichard, Parry Klassen,Sebastian Braum, Daniel Abruzini, Terry Bechtel	13
11/10/10	Stockton	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	155
11/16/10	Simms	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	201
11/18/10	Stockton	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	120
11/18/10	Lodi	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	158
11/18/10	San Joaquin Co	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Terry Prichard	117
11/30/10	California, Parlier	IPM Alfalfa Workshop-- Managing Pests While Protecting the Environment. Presentation: Mitigation Practices to Protect Water Quality	Terry Prichard	120

Date	Area	Details	Who	Attendees
12/1/10	California, Visalia	California Alfalfa Symposium -- Preventing Offsite Movement of Pesticide Residues in Alfalfa and Corn	Terry Prichard	463
12/6/10	Stockton	A Role for PCAs/CCAs in Water Quality Protection Meeting. Discussed new ILRP requirements, a PCA's role in water quality issues, and the relationship between CCA programs and water quality issues. Also discussed were pesticide fate and pathways to surface	Terry Prichard, Mike Wackman, Rachelle Antinetti, Mick Canevari, Terry Bechtel, Sebatian Braum	36
12/7/10	Stockton	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	158
12/8/10	Lodi	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Mike Wackman	176
12/8/10	Simms	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Terry Prichard	99
12/8/10	San Joaquin Co	San Joaquin County Agricultural Commissioner Meeting. Reviewed past years pesticide use and Coalition monitoring results. Discussed relevant regulations and applicable management practices, among other topics.	Terry Prichard	68
1/13/11	Mokelumne	Coalition Members, walnuts and grapes	Terry Prichard, Paul Verdegaal,Mike Wackman,Rachelle Antinetti	17
1/18/11	San Joaquin Co	Asparagus growers San Joaquin Co.	Terry Prichard, Brenna Aegeter	35
1/19/11	Terminous	Coalition Members alfalfa	Terry Prichard, Mick Canevari,Mike Wackman	12
1/20/11	French camp	Coalition Members walnuts, grapes, and alfalfa	Terry Prichard, Mick Canevari Mike Wackman,	25

Date	Area	Details	Who	Attendees
2/1/11	Lodi	Grape Growers	Terry Prichard	324
2/16/11	Stockton area	Large grower meeting hosted in part by Spray Safe; meeting held in San Joaquin Agricultural Center.	Terry Prichard & Kurt Hembree	335
			Total	6564